

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 December 1, 2019 – May 31, 2020
Prepared by Molly McCammon, Project PI on June 23, 2020

1.0. PROGRESS AND ACCOMPLISHMENTS

1.1. Regional Governance & Management Subsystem

1.1.1. Support ongoing board and committee activities.

- The AOOS Board met December 16, 2019, focusing on strategic planning for the FY21-25 NOAA cooperative agreement proposal, and again on May 14, 2020 to approve the Year 5 core work plan.
- The North Pacific Fishery Management Council appointed Kenny Down as the council's representative on the board. The North Pacific Research Board's new executive director Lynn Palensky will now represent NPRB on the board. New board member orientations were held for Kenny and Lynn, as well ADF&G's Katherine Howard.
- The AOOS Data Management Advisory Committee was formally disbanded by board action at the May 14, 2020 meeting. The IOOS DMAC efforts and other data collaborations will provide continued input into the AOOS data management system, with the new Regional Ocean Data Sharing position focusing on stakeholder engagement and product development.
- AOOS and Axiom staff are developing a final report on implementation of the recommendations developed by an external review committee held in December 2017.

1.1.2. Provide ongoing fiscal and administrative oversight for program.

- This reporting period has been dominated by the program's response to the COVID-19 pandemic, which resulted in a complete shutdown of the Anchorage office and transition to remote workspaces on March 18. Staff have been working with our principal investigators to ensure that the majority of our observing assets are functioning as planned, although there are some delays in deployments.
- Staff released a Request for Project Ideas in March to broadly solicit project ideas for potential inclusion in the next AOOS 5-year proposal to the IOOS office, which is due December 31, 2020. A technical review of those ideas will be held in late June.
- Executive Director Molly McCammon conducted an annual evaluation for Holly Kent, Director of Administration and Outreach.
- Subawards and contracts for Year 4 of our NOAA Cooperative Agreement continued to be implemented.
- AOOS continues to seek additional external funding, and in this reporting period, received a new contract with the Office of Naval Research for support of the Animal Telemetry Network Data Assembly Center, and submitted two proposals, one of which was funded.

1.1.3. Support national and international partnerships and collaborations.

- McCammon represented AOOS at NOAA's OA planning workshop January 7-10.
- McCammon co-chairs a committee planning a fall workshop on how to sustain ocean observations, supported by the National Academy of Sciences Ocean Studies Board. That workshop will now be held virtually September 16-18.
- McCammon sits on the IOOS Federal Advisory Committee, which met in Washington DC February 11-12 and virtually April 7. 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, Janzen and Axiom gave talks and posters at the February 17-21

- AGU/TOS/ASLO Ocean Sciences meeting in San Diego.
- McCammon participated in the Center for Open Data Enterprise's February 10 Roundtable on Putting Ocean Data to Use.
- McCammon participated in the National Academy of Sciences' Committee on Offshore Science and Assessment visit to Anchorage February 13, describing how AOOS interfaces with BOEM.
- McCammon met in Washington DC March 4-5 for the annual spring IOOS meeting. She is also participating in the IOOS Association's strategic planning sessions, as well as IOOS Association Public Policy calls.
- McCammon is a member of the Consortium for Ocean Leadership and participates in their member calls, as well as their Public Policy Committee calls.
- McCammon is co-lead of the IARPC Environmental Intelligence Collaboration Team, which hosted a meeting April 22 on the status of Arctic research cruises. AOOS is helping to maintain that status report.
- McCammon sits on NOAA Science Advisory Board's Ecosystem Sciences Management Working Group which met virtually May 5-6 and is working on a report on "Managing under deep uncertainty."
- McCammon is representing SAON on the planning committee for an Arctic workshop as part of the upcoming UN Decade of Ocean Science (2021-2030). In-person workshops have been replaced (due to COVID-19 travel restrictions) by online planning sessions this fall/winter and a March 2021 online workshop.
- McCammon participated in 3 days of a virtual Arctic Observing Summit March 31-April 2. She largely participated in WG5: Arctic Observations in the context of Global Observing Initiatives. That group recommended initiating new discussions regarding development of an Arctic GOOS.

1.1.4. Support Alaska and regional partnerships and collaborations.

- Janzen represented AOOS at the National Fish and Wildlife Foundation's Technical Working Group for a Coastal Resilience Assessment January 8.
- Axiom participated in two workshops focused on Alaska mariculture from January 21-24, hosted by NOAA and the Alaska Shellfish Growers Association.
- Janzen represented AOOS data management efforts at the PI meetings for the EVOS Trustee Council Gulf Watch Alaska and Herring programs in January, February and May.
- Janzen participated in the annual PI meeting in January for the Central Beaufort Sea Wave and Hydrodynamic Modeling Study.
- Axiom hosted the PI Team meeting on January 31 for the project Building Coupled Storm Surge and Wave Operational Forecasting Capacity for Western Alaska (Johannes Westerink, Notre Dame).
- AOOS led or co-led a number of sessions at the Alaska Forum on the Environment February 10-14, including two on Bering Sea changes, one on microplastics as part of a Marine Debris Summit with EPA, and another on Harmful Algal Blooms.
- The Alaska Water Level Watch annual meeting was held virtually April 29.
- 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.
- 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 a printed newsletter in January, an e-newsletter in December to a list of over 2,000, and an annual report in March.
- Kent has been working with a contractor on a refresh of the AOOS website.

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 expanded their engagement activities in the past 6 months in preparation for the next AOOS 5-year proposal to NOAA. These included meetings and/or presentations with ACCAP, the AK Marine Policy Forum, the Arctic Domain Awareness Center, Arctic ERMA, AK Ocean Cluster, the Aleutian Bering Sea and Western Landscape Conservation Cooperatives, Alaska Sea Grant, North Pacific Fishery Management Council, and NOAA's AK Regional Collaboration team.

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

Alaska Ocean Acidification Network

- Network director Darcy Dugan hosted an ocean acidification (OA) townhall at the Alaska Marine Science Symposium in January where 10 researchers highlighted their research activities, results, and plans. She also helped organize an OA session at the Alaska Forum for the Environment in February.
- Dugan organized the first statewide meeting of community-based ocean acidification samplers, allowing people from different regions to meet, hear about recent results, and ask questions. She also launched a new webpage on community-based OA monitoring in Alaska.
- Dugan worked with the OA Network steering committee and other researchers to draft an OA build-out plan identifying priority areas for monitoring in the next 5 years.
- Dugan worked with OA researchers to develop and launch an Alaska OA Data Catalog, listing known OA data sets and providing links to available data.
- 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 facilitated two meetings of the Alaska OA Network steering committee to keep track of progress and identify new activities and objectives for the network.

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.
- Dugan produced the 2019 HAB Summary by Region, describing research and monitoring activities and results from around the state.
- Dugan helped organize a HABS session with breakout groups during the Alaska Forum for the Environment in February.
- McCammon worked with partners to secure IOOS funding for a full-time HABS coordinator that will start in 2020 after a candidate has been identified.

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.
- The AK Water Level Watch annual meeting was held virtually April 29.
- See section 1.3.2.5 for information about the new water level data portal.

1.2.4. Support partnerships with marine education and outreach programs.

- Kent participated on the organizing committee for the 2020 Communicating Ocean

Sciences Workshop (COSW) featuring Climatologist Brian Brettschneider in conjunction with AMSS. This committee also organized a one-day science communication workshop in January led by the American Geophysical Union's Sharing Sciences group.

- Staff supported 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 January, March and May 2020.

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

- AOOS staff serve on the organizing committee and helped coordinate workshops and keynote addresses for symposium week. AOOS supported two town halls: one on ocean acidification and another focusing on private-public partnerships as a follow-up to the 2019 White House Summit on Science and Technology Partnerships. AOOS also supported a workshop on Bering Sea Change, as well as the annual Communicating Ocean Science Workshop. AOOS and the IOOS Program Office also supported training seminars about NEPA, and with Axiom Data Science, a metadata workshop.

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.

1.3. 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: May 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 service existing peripheral equipment at the Port of Kodiak; Original completion Date: July 2019.
Status: Delayed – Site survey completed, final permission from site host obtained. Planning to install this summer 2020.
 - Install new weather sensors at Ship Island; Original completion Date: August 2019.
Status: Completed – August 2019.
 - Install new weather sensors and service existing peripheral equipment in proximity of Saxman; Original completion Date: September 2019.
Status: Delayed - site host permission granted, planning to install summer 2020.
 - Install new weather sensors at George Rock; Original completion Date: May 2020.
Status: Completed – September 2019.
 - Recapitalize three existing weather sensors at Kodiak Gull Island, Homer Port, and Tenakee Springs; Original completion Date: May 2020.
Status: On Track – Kodiak Gull Island and Homer Port completed, Tenakee Springs to be installed summer 2020.
 - Install three weather reporting stations in gapped areas of Arctic waters and the associated AIS (Automatic Identification System) transmitters; Original Completion Date: September 2020.

- Status: Delayed until 2021 due to covid-19 travel restrictions.
- 1.3.1.3. Support sea ice radar in Barrow.
- **Subaward to University of Alaska Fairbanks (UAF), Geophysical Institute.**
 - Replace the UAF coastal sea ice radar system in Utqiagvik. Original Completion Date: May 2019.
Status: Complete. – System needs complete replacement. PI has received funds to do so, and will not need AOOS support for next 2 years.
- 1.3.1.4. Sustain critical wave buoys for navigation safety.
- **Operate and maintain Cook Inlet buoy; Original completion date: May 2020.**
Status: Complete.
- 1.3.1.5. 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.**
 - Monitor HF Radar and power systems and perform maintenance, as necessary, until freeze-up; Original Completion Date: January 2020.
Status: Complete.
 - Winterize systems to combat wear and tear on equipment; Original Completion Date: January 2020.
Status: Complete.
- 1.3.1.6. 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.**
 - Design and fabricate RPM Lite; Original Completion Date: May 2020.
Status: Delayed – The initial design for an RPM Lite has been discussed and diagrams have been drawn up by APRS World, LLC. We still need to make modifications to the design to make it more efficient for our options, but modification discussions have been cut short due to COVID-19 impacts and staffing.
 - Test RPM Lite; Original Completion Date: May 2021.
Status: On-Track/Delayed – Though dependent on how the new timeline for the design and fabrication of the RPM Lite develops, we are hopeful to still be able to test the system by May 2021.
 - Deploy field sites in pilot locations. Status: Delayed due to covid. 2 sites deployed summer 2019. Third site to be deployed in 2020.
- 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: On track. Four of the five site installations complete, but only two of these stations are currently operational and reporting data real time at the time of this report.
 - Install tide staffs for the documentation of maximum storm water levels at locations that can be opportunistically travelled to. Status: Complete. Installation occurred at Nunam Iqua.
 - Create color-indexed maps for flood communication at communities where tide datums, community infrastructure, and elevation information are available. Status: On Track. Three western AK communities (Pt. Lay, Wainwright and Kotlik) will have new tidal datums established in 2020.
 - Develop state database for coastal storm flood documentation. Status: Parts Delayed; but other components are On Track. The DGGS catalog of historical storm events was

- updated, and new storm photos posted to the database.
 - Inform the National Weather Service (NWS) of potential flood impacts in advance of storm events. Status: on track. No new consultations occurred during this reporting period due to low storm activity.
 - Maintain Alaska Water Level Watch Webpage. Status: on track. The AWLW Website was updated with content and site formatting.
 - Train NWS and SEOC to use coastal flood mapping products. Status: on track. DGGS presented new materials on flood impact maps created by the Digital Coast Fellow to the Alaska NWS during this period, but not to the SEOC.
 - Attend conferences and meetings for discussions on water level sensors and deployments. Status: Complete
 - Contract with JOA Surveys to install a tide station at Naknek; Original Completion Date: May 2020. Status: Complete.
 - Monitoring coastal hazard conditions with near real-time camera systems. Status: Delayed to 2021 covid-19 related.
 - **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 by end of 2020.
- 1.3.2.2. Increase wave observations for forecasting and planning
- **Deploy & support CDIP buoy in Nome;** Original completion date: May 2020.
Status: Complete.
 - **Support operations and maintenance for the NREL owned Kodiak CDIP buoy;** Original Completion Date: May 2020.
Status: Completed.
- 1.3.2.3. Initiate statewide geospatial mapping coordination
- Funding was 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. A survey to help prioritize locations for coastal mapping was conducted in spring 2019, with the results compiled into a draft report that was circulated for review. It was modified in response to the November Presidential Memorandum which called for strategies on oceans and Alaska coastal mapping. The revamped draft was released to the public in June by the White House Office of Science and Technology Policy and Council on Environmental Quality. The strategist also is helping develop a Coastal Subcommittee for the Alaska Mapping Executive Committee (AMEC) and an implementation plan for the presidential strategy that will incorporate much of the prior work done on the Alaska strategy. Due to COVID-19, the 3rd Alaska Coastal Mapping Summit which was scheduled for April has been postponed until further notice.
 - In tandem with the AMEC Coastal Mapping Subcommittee, the strategist began working with the state's new geographic information officer to form an Alaska Geospatial Council Coastal Technical Working Group. The formation of this group is still underway, and participation will be more widely available compared with the AMEC Coastal Subcommittee which will only be open to AMEC member agencies.
- 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 Atka Island, Bessie Mountain, Deception Hills, Dot Lake, and the Cordova Ski Area from June through September 2019. Original

Completion Date: May 2020.

Status: Completed.

- Stream seismic data from the Alaska Earthquake Center to the Tsunami Warning Center for all supported sites. Original Completion Date: May 2020.

Status: On Track - Seismic data was streamed 24/7 in real-time for all sites.

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: May 2020.

Status: Complete

- Ingest planned Tier B and C water level station data; Original completion date: May 2020.

Status: Complete

- Define and populate Station Definition fields, including implementation of station narratives; Original completion date: February 2020.

Status: Complete

- Develop system to host, publish, track, and update station logs; Original completion date: February 2020.

Status: Complete

- Tier (or "intended use") assignment - define intended use namespace and assign them to sensors; Original completion date: February 2020.

Status: Complete

- Improve heatmap visualizations for water level observations; Original completion date: May 2020.

Status: Complete

- Scope ability to change datums on graphs and displays; Original completion date: May 2020.

Status: Complete

- Pilot ingest and visualization of high-water mark data; Original completion date: May 2020.

Status: Complete

- Explore converting elevations from a tidal to geodetic elevation at a specific station in the Water Level Watch portal; Original completion date: May 2020.

Status: Complete

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: May 2020.

Status: Complete. Although cruise was shortened due to covid-19 restrictions.

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.**

- Monitor incoming data (ongoing); Original Completion Date: May 2020

Status: On Track.

- Purchase equipment; Original Completion Date: October 2019

Status: Some COVID-19 related delays. Mostly on-track.

- Continue updates of project website; Original Completion Date: March 2020

Status: On Track.

- Preparations for 2020 mooring turn-arounds; Original Completion Date: May 2020
Status: On Track.
 - Full set of 2nd moorings deployment following recovery of Year 1 moorings for both CEO and GEO; Original Completion Date: June 2020
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: Delayed. Glider at Teledyne for major overhaul.
 - Deploy glider in southern Chukchi Sea using ship of opportunity; Original Completion Date: July 2020.
Status: On track. pending finding a suitable deployment vessel.
 - At sea data collection. Maintain website with real time acoustic detections and oceanographic data; Original Completion Date: October 2020.
Status: On track. Pending glider deployment.
 - Glider recovered, acoustic and oceanographic data downloaded; Original Completion Date: October 2020.
Status: On track
 - Purchase two ST500 hydrophone packages and deploy on Chukchi Ecosystem Observatory array; Original Completion Date: August 2020.
Status: On track.
- 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 summer 2020.
 - Glider pilot training; Original Completion Date: February 2020.
Status: Delayed but on-track for completion fall 2020.
 - Two Alaska region glider deployments; Original Completion Date: December 2020.
Status: On Track.
 - Development of EAFM Indices; Original Completion Date: May 2021.
Status: On Track.
- 1.3.3.5. 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.**
 - Clean conductivity sensor at Cordova tide station; Original Completion Date: December 2019.
Status: Complete.
 - Upload data from OTN array; Original Completion Date: February 2020
Status: Complete.
 - Submit data to OTN, upload PWSSC data to PWSSC historical data workspace; Original Completion Date: March 2020.
Status: Complete.
 - Clean conductivity sensor at Cordova tide station; Original Completion Date: March 2020.
Status: Complete.
 - Send conductivity sensor for calibration; Original Completion Date: April 2020

Status: Delayed covid-19 related.

- **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: May 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: May 2020.
Status: Seasonal cross-bay survey in outer Kachemak Bay transect was not completed due to adverse weather conditions, however additional along-bay surveys were completed in the outer bay during the reporting period.
 - Conduct two seasonal oceanographic surveys on an along-Kachemak Bay transect (spring, summer); Original Completion Date: May 2020.
Status: Complete.
 - Deliver quality assured/quality controlled oceanographic data to AOOS data contractor Axiom within 6 months; Original Completion Date: May 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: May 2020.
Status: Complete.

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

- **Subaward to Axiom Data Science.** Original completion Date: May 31, 2021.
Status: On Track. Preliminary discussions held with North Pacific Fisheries Management Council and Alaska Fishery Science Center.

1.3.3.7. 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.**
Status: On Track.
- **Contract to Axiom Data Science.**
Status: On Track

1.3.4. *Water Quality*

1.3.4.1. Sustain Ocean acidification (OA) monitoring including moorings, sampling along the Seward Line, Burkolators 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: May 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: May 2020.
Status: Complete.
- **Subaward to University of Alaska Fairbanks to conduct a regional Ocean Acidification Monitoring Cruise in the Gulf of Alaska;** Original Completion Date: May 2020.
Status: Delayed. Covid-19 related.
- **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 fall 2020.

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 2020. 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.

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.**
 - Research Cruise for the Distributed Biological Observatory (DBO); Original Completion Date: May 2020. Status: Delayed – Cruise completed; sample analysis is delayed due to covid-19, to be completed before December 2021.
 - Participate in a national meeting or workshop; Original Completion Date: May 2020. Status: Delayed due to travel restrictions from covid-19.
- **Subaward to the University of Alaska Fairbanks 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: May 2020. Status: Delayed due to covid-19.
 - Support equipment maintenance and turnaround for OA surface mooring at M2; Original Completion Date: May 2020. Status: Delayed due to covid-19.
 - Participate in a national meeting or workshop to present any new findings; Original Completion Date: May 2020. Status: Delayed due to covid-19

1.3.5. *Streamline access to Observations*

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.

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, the Cluster storage migration was completed for data volume rebalance. The system firewall was upgraded for additional bandwidth/security, as well a secondary failover/standby unit was

added for high availability. The server bootstrapping was enhanced for greater automation and reduced deployment time of new hardware. Improved metrics and system performance monitoring, including data portal uptime, database performance, data center power usage, and network traffic, were completed.

Status: Complete.

1.4.1.2. Data Portal Development.

- Two portal versions were developed and released: v2.11a and v2.12. AOOS data portal Version 2.11 updates included expanded data quality flags, v2 backend integration, and custom unit manager. Backend timeseries caching was also incorporated to improve portal responsiveness to real-time conditions. Version 2.12 addresses user-defined improvements, implementation of service error messages, and continuation of portal code migration to an open source platform. Prototype versions of platform tracks were introduced for optimization in future releases. Version release notes are available at:

<https://axiomdatascience.com/portal-updates/>

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 [439 historical timeseries datasets](#) 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. Last, a prototype version of [test configuration management](#) for users to store and manage configurations across parameters and regions was implemented. Configuration management will be expanded upon in the next phase of the project to give users access and control of more complex QARTOD features and 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, 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. Two quarterly progress review meetings were 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 attended or presented at the following meetings related to AOOS DMAC activities.
 - Ocean Sciences Meeting in February 2020.
 - Jesse Lopez (Axiom) delivered a presentation on applying machine-learning methods to estimate orca populations from acoustic data collected by Gulf Watch Alaska researchers.
 - Will Koeppen supported a talk “*Coordinating Observations of Arctic Change: a Model for the Greater Arctic Region*” and poster presentation “*Building Data Access for Sharing non-NWLON Water Level Information in Alaska*” delivered by AOOS’s Carol Janzen.

- Axiom staff also participated in a special session focused on data discovery through IOOS Regional Association portal where Molly MacCammon gave a talk on Arctic data tools. Additionally, Brian Stone (Axiom) co-presented on a new hurricane tool developed with the Southeast Ocean Observing Regional Association (SECOORA) in the same session.
 - Exxon Valdez Oil Spill Trustee Council
 - Carol Janzen and Stacey Buckelew (Axiom) provided presentations on the Data Management Program, including data portal overviews and hands-on demonstrations/training for the Public Advisory Committee members and Science Panel during a workshop held February 25 – 27.
 - NOAA Alaska Mariculture Workshop
 - The NOAA Alaska Mariculture Workshop and the Alaska Shellfish Growers Association meetings brought together growers, hatcheries, regulators, researchers, funding sources, and policy makers to discuss current issues and identify needs related to research, policy/permitting, and access to capital to help develop mariculture in Alaska. Axiom presented a prototype version of the Mariculture Map, a web-based tool offering investors, regulators, and operators interactive access to pertinent environmental, oceanographic and social data to inform sustainable mariculture development. An hour was dedicated to a hands-on exercise using the tool and engaging in facilitation discussion about additional information to meet user needs. Individual meetings were also held with growers and permit regulators to gather additional feedback to further improve the tool. With a grant from the Pacific State Marine Fisheries Commission to the Alaska Fisheries Development Foundation, the Mariculture Map will be operationalized by responding to end user feedback and incorporating additional data needs (including data from the Alaska HAB network) to help inform mariculture stakeholders.
 - Alaska Department of Environmental Conservation
 - On December 18, Axiom hosted a data portal workshop for a group of 13 decision-makers at the Alaska Department of Environmental Conservation. The workshop provided hands-on experience discovering, accessing, and analyzing ocean and coastal data through the AOOS Data System

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:

- Reworking 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.
- Disabling the seasonal [Gulf of Alaska Ecosystem Observatory GEO3-2019](#) data streams.
- Applying QARTOD to the [UAF Foggy Bay buoy](#) and correcting the seasonal relocated in the

data stream.

- Backfilling 2017 data gaps and applying QARTOD to all historical data for the [Marine Exchange of Alaska sensors](#).
- Updating the [Alaska OA data catalogue](#) through March 2020.
- Migrating data stream sources from NDBC to CDIP for buoys in the Alaska region.
- Refreshing the [GAK1 Mooring visualization](#) with data through 2019.
- Updating the [run timing outlook and forecast summary for Chinook salmon](#) in the Yukon River Delta through 2020.
- Additional bug fixes, notification, and attributions updates, including resolving FAA ID bug for 3 station locations, updating Lower Cook Inlet wave buoy station notification, and resolving sensor attribution requests for University of Alaska Fairbanks instruments.

Status: Complete.

1.4.3.2. Ingest new datasets and metadata.

Activities completed to ingest new data and metadata included:

- Adding 12 new real-time and historical stations meteorological stations from the [Friends of Chugach National Forest Avalanche Information Center](#) (F-CNFAIC).
- Adding new photo and video imagery to the [ShoreZone imagery layer for the Alaska Peninsula/Aleutian Islands region](#).
- Ingesting and visualizing two years (2017-2019) of [surface seawater data](#) collected from the [Alaska state ferry](#) during weekly transits between Washington and Alaska.
- Ingesting the [Nelson Lagoon, Alaska, Water Level station](#) to the 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 was completed and efforts are ongoing to incorporate feedback and process revisions. 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, three thematic data views were created to be featured on the new AOOS website:
 - [Long-term temperatures in the Gulf of Alaska](#)
 - [Declining sea ice in the Arctic off the coast of Utqiagvik](#)
 - [Ocean acidification measured in Kachemak Bay](#)

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 2020.

Status: On Track

- 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.
- Operationalize and enhance the ATN DAC system tools: In order to efficiently scale the ATN DAC to ingest greater volumes of tag deployment data, development work was done to automate the assigning of individual tag deployments to projects registered in the ATN DAC. During the performance period, Axiom finalized backend engineering work to automate binning of project tag deployment that, given a platform or group of platforms and a binning strategy configuration object: computes the aggregate bins for each binning strategy, stores them into a standardized Postgres table, and notifies GeoServer that the table is ready through GeoServer updater service. Development was done to automate the messaging system (which currently is a manual effort) to routinely search for new tag data and add appropriate data handling labels in the platform service. To alleviate tag display error in the ATN DAC, an internal service was augmented to send an alert when corrupt files are ingested so they can be corrected at the source.
- Enhance data ingestion pathway from tag manufacturers into the ATN data portal: In order to maintain a continuous data ingestion pipeline from manufacturer into the ATN DAC, the following activities occurred:
 - Wildlife Computers data ingest scripts were updated to honor deployment start/end dates to remove tag test data from appearing in the data portal,
 - Scripts were modified for ingesting and displaying 'G' location class data for GPS tags harvested from Wildlife Computers. Axiom worked with Wildlife Computers to correct and re-ingest a batch of tag data with post-processing and labelling errors.
 - Following a tag inventory update at SMRU, the RefID were updated for all SMRU tags and re-ingested to the ATN DAC.
 - Three technical calls were held with OTN-Axiom to respond to ATN requirements for acoustic data. An approach for developing a data harvest pipeline from OTN endpoints to harvest and display US acoustic telemetry project data and metadata in the ATN DAC portal was identified. Preliminary tests were run to connect ATN to OTN data endpoints.
- Scope and enhance technical strategy for dTAG data access and dissemination through the ATN DAC data portal: Axiom participated in two technical scoping sessions with dTAG researchers. Researchers are transferring scripts from MatLab to R to ease script migration to the Research Workspace, where Jupyter Notebooks will be tested as a digital sandbox for researchers to process data using dTAG tools. Due to the technical complexities of post-processing of this tag type, effort will be ongoing through Year 3.
- Integrate tools and packages into the Research Workspace Python and R Notebook kernels to support data analysis and product development by ATN PIs: The Foie Gras State Space Model (SSM) is one of a few SSMs that was developed to transform Argos (or GLS) satellite location data into an estimated "most-probable" track. The Foie Gras model is implemented as an R package on CRAN and maintained by Ian Johnson. The Animal Telemetry Network would like to scope implementation of this model to produce modeled tracks for all ATN tracks for

visualization within the ATN portal. During this performance period, the model was run on a sample variety of ATN-provided tracks to 1) visually determine how well the model performs when generally parameterized, b) inform discussions of how to parameterize the model on a broad scale, c) inform next steps in operationalization to the ATN DAC. Meetings were scheduled with Ian Johnson to review and troubleshoot the model, and to discuss adjusting the time-step for the random walk model.

- Publish and archive ATN data to national archives and data centers, making it available for research, management, and long-term preservation: During this period 9 animal telemetry datasets have been archived with DataONE using the automated pathway from the Research Workspace DataOne Member Node. An additional 2 datasets were prepared to a near-final curation state and are awaiting final revisions from the PI prior to dataset archive.
- Maintain and enhance ATN data portal to showcase animal telemetry datasets: During the performance period, routine and non-routine activities occurred to ensure continuous showcasing of animal telemetry data. The ATN DAC portal was maintained and enhanced to expose data from 99 projects encompassing 3625 tag deployments. 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. Further, a timezone bug was corrected to display local time relative to browser state, and a beta version of user time zone selection was created for integration into a future portal release.
- Provide technical assistance to ATN PIs and the broader community interacting with the ATN DAC system: 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. During the performance period 30 new projects totaling 1539 deployments were added to the ATN DAC. Further, a workshop originally scheduled for May 4-6, 2020 in the Northeast region was held as a virtual training event. Over 40 people participated to learn about the ATN DAC and how to contribute their data.
- Provide project management support for the ATN DAC: Axiom maintained participation in regular weekly or bi-weekly calls with project partners to provide progress summaries and coordinate on Year 2 activities of this project. Project tasks were assigned and tracked using two Trello boards (ATN DAC and ATN Data Coordination). Additionally, a research proposal for Years 3-4 of the project was developed in partnership with IOOS and submitted to ONR.

1.4.5.2. USGS Geospatial Data Portal Development; Original Completion Date: May 2020

Status: Complete

- AWS Infrastructure and Support: Axiom worked with Julia Moriarty to use AWS to run and analyze multi-core model runs with the COAWST (Coupled Ocean Atmosphere Sediment Transport) model. This included setting up AWS for use by Julia and her colleagues. Further, Axiom set up a monthly budget of \$2,000 to get started and email alerts to Axiom and Julia when the forecasted costs will exceed 80% of the budget. Throughout this performance period, the monthly budget and storage allowance was maintained.
- Photography and Video Portal Maintenance: The coastal photograph and video data portal (originally developed by USGS) was migrated to a next generation data platform and branded as an IOOS product available at: <https://video.ioos.us/>. The intent of this migration was to make the data portal and its associated imagery accessible to a broader user community. The activities completed include:
 - created share code to port existing data layers to new imagery service,
 - updated portal configuration to next generation infrastructure,
 - changed branding logo for portal, help documentation, and landing page from USGS to IOOS, and
 - established custom portal url.
- Oceanographic Model and Data Portal Maintenance: The Video and Photograph Portal also

contains an Oceanographic Model data layer, which was maintained under this performance period to ensure its continuous operation, including maintaining connection between the Oceanographic Time-Series Database and the IOOS Sensor Map and the greater IOOS Enterprise. During this performance period, the following activities occurred:

- investigated and resolved invalid data being displayed from USGS CMG sensor datasets ([link](#)),
- added a ragged timeSeriesProfile support to pocean-core,
- resolved a timestamp bug that prevented future state models from being accessible through the USGS CMG data portal.

1.4.5.3. Maintain and Enhance Data Access Service Software - ERDDAP and Environmental Sensor Map and Global Data Integration; Original Completion Date: May 2020

Status: Complete

- **Maintain and Enhance Data Access Service Software – ERDDAP:** The key software stewardship activities include the following subtasks:
 - **Defining High-Level Feature Roadmaps:** 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:** 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. A technical webinar was held in March 2020 ([presentation link](#)) with IOOS DMAC representatives to review the project roadmap, comment on the proposed ERDDAP guidelines, and test implementations of the metadata profile.
 - **Development & Implementation:** 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; and 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: 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; 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.
- Environmental Sensor Map and Global Data Integration
 - Defining a high-level roadmap: The high-level roadmap for this project was defined in two documents: i) [FY19 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; 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; During this performance period, version 2.11 was updated to include key features and bug fixes that precede the version 2.12 release. Elements of this update included: migrating elements of portal code to open source platform (charts, etc.); adding a custom unit display manager for users; and performance optimization and hardened cache service for historical datasets using v2 service. In March 2020, version 2.12 of the Environmental Sensor Map was released to address user-defined improvements, implementation of service error messages, and continuation of portal code migration to an open source platform. New features available in v2.12 include:
 - custom narratives available on station level pages
 - continuation of portal code migration to open source platform for time slider and charting features
 - introduction of service error messages
 - removal of dependency on user state service for load
 - bug fixes relative to UTC time zone display in the browser

During the performance period, approximately 125 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 (June 1, 2020):

- All stations (includes both historic and real-time stations, across the entire globe):
 - 39,717 stations
 - 150 data sources across 253 affiliates

- 300 unique parameters
- Real-time stations ("real-time" stations have data from the past week):
 - 28,552 stations with observations in the past week, across 76 data sources
 - Approximately 71,200 sensors with observations in the past week
 - Approximately 49,088,000 sensor observations per week

Historic Metrics (December 1, 2019) for comparison:

- All stations (includes both historic and real-time stations, across the entire globe):
 - 39,593 stations
 - 138 data sources across 237 affiliates
 - 226 unique parameters
- Real-time stations ("real-time" stations have data from the past week):
 - 27,948 stations with observations in the past week, across 77 data sources
 - Approximately 70,600 sensors with observations in the past week
 - Approximately 46,219,000 sensor observations per week

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/. 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 net CDF processing and export, including generation of proper QC metadata
- Completely revamped documentation and notebook examples
- Performance review and improved testing speeds
- Improved documentation; A summary of the version releases is below and full release notes can be found: <https://axiomdatascience.com/portal-updates/>.

1.4.5.4. MBON Portal Development; Original Completion Date: May 2020

Status: Complete

- Tool development; 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.
- 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/>.
- 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 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. A draft visualization of the dataset was developed and four meetings were held with data providers to update the database compilation relative to desired visualization features. Changes made include adding common species names; adjustments to abiotic species handling; customization of dataset download; and inclusion of data post-processing for various species measurements (i.e. mean counts per area, rugosity, etc.). Periodic updates were made twice to the [Effort-based](#)

[surveys, Northern and Central California Beaches: Seabirds and Marine Mammals](#) dataset in order to make data current through January 2020. Axiom worked with the data provider to resolve errors with species naming and classification, relative to feedback from end users. Axiom worked with data providers to refresh the [Zooplankton Species Distribution and Abundance Data](#), [Applied California Current Ecosystem Studies \(ACCESS\)](#) data layer to include an additional three years of data (2014-2017) and expanded the taxonomic compilation to include all zooplankton species. Axiom worked with NOAA's National Centers for Coastal Ocean Science (NCCOS) to update the [National Benthic Inventory](#) visualization in the MBON data portal to that latest version of the data available from OBIS, in addition to refreshing the program url. A pilot visualization of the [SBC LTER: Time series of quarterly Net CDF files of kelp biomass in the canopy from Landsat imagery](#) was developed that takes advantage of a new server-side hex bin application that is designed to more quickly serve large data volumes to the user by optimizing data pre-binning and cache services. Effort is ongoing to optimize the bin level for zoom mapping and zoom hexes into individual location points.

- Conduct technical scoping to identify technical improvements to building data views by allowing a data layer to be remote e.g. from OBIS; Technical assistance was provided to data providers for aligning data to the Darwin Core and OBIS—ENV formats. All new datasets (listed above) were transformed to the Darwin Core standard for ingestion and access through the MBON Data Portal. Two additional AMBON datasets were formatted in the OBIS-ENV format and submitted to USGS Abigail Benson for review prior to submitting to OBIS. Throughout the performance period, standard output services that allow users to retrieve biological data from the MBON Portal were maintained.
- Release Planning and Management; The MBON data portal was originally developed as a pilot project to demonstrate standardizing and making available a number of biodiversity datasets alongside other physical and biological data. The portal infrastructure still remains at a demonstration level, thus requiring dedicated attention to improve the portal front and backend systems to sustain the incremental growth of biodiversity data being hosted. During this performance period, limitations of the current MBON portal infrastructure were met when handling large timeseries biodiversity datasets in the OBIS-format (i.e. PCRMP and National Benthic Inventory) where millions of data rows are being handled. Effort was invested into attempting to improve the responsiveness of the data visualizations by removing non-essential elements from the OBIS-MoF files, such as absent and repetitious measurement records. While performance improvements were realized using this approach, additional technical developments to the MBON portal infrastructure were identified that would further improve data delivery and discoverability to the client. Those technical tasks were incorporated into the FY20 MBON data portal workplan in effort to advance the platform beyond a demonstration level and improve the overall user experience for biodiversity data.
- 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, as well as the IOOS DMAC Code Sprint to discuss streamlined biodiversity data standards for OBIS-ENV.

1.4.5.5. Finalize HFR Range Series File Archiving through the Research Workspace; Original Completion Date: May 2020
Status: Complete.

- Provide space in the Research Workspace to store all range series files for all HFR operators within the IOOS HFRNet; 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. Additionally, 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 into: <https://hfradar.ioos.us/>. Additionally, HFR operators will be engaged to gather feedback and incorporate updates to the data inventory, documentation, and other data products needed to improve the accessibility and reuse of these data among the community.

1.4.5.6. Sairdron: Developing quality test configurations; Original Completion Date: May 2020.

Status: Complete

- Variables: Of the 32 variables measured by Sairdron this project will deliver an implementation of 8 variables; Axiom worked with NOAA PMEL to narrow the priority variables to be quality controlled during this project. Those variables are: air temperature, relative humidity, atmospheric pressure, wind data, salinity, sea surface water temperature (from two sensors), fluorescence and oxygen concentration.
- Quality control foundation: The basis for developing additional quality control software will be the existing open-source IOOS Quality Control community software package. The software is an implementation of the U.S. Integrated Ocean Observing System (IOOS) developed Quality Assurance for Real Time Observation Data (QARTOD) manuals; During this performance period, a prototype QARTOD configuration management tool was made publicly accessible through the IOOS Environmental Sensor Map and IOOS regional data portals using the open-source IOOS Quality Control community software package.
A new configuration management tool was developed to support the creation of regional bounds and temporal windows on top of the standard QC configurations. This was done so a single configuration object could be applied to a moving platform over time. Originally there was a 1:1 relationship between a dataset and a confirmation object, now multiple configuration objects will be able to be applied to a single dataset, taking into account the location of the object in both space and time to account for varying oceanic and atmospheric conditions experienced by long-term deployments of Sairdron instruments. Updates to the `ioos_qc` software to support the new configuration syntax were submitted as a pull request.
- Adaptive Quality Control: Using the 2017 to 2019 Arctic Sairdron data, we will develop software to ingest data, and flag individual values using the QARTOD flagging scheme; Datasets from mobile sensors and climatological datasets were used to develop data-driven methodologies to generate QC test configurations. The software implementation of this methodology will be integrated into the `ioos_qc` library. Access was gained to candidate datasets from NOAA Pacific Marine Environmental Laboratory (PMEL) and Sairdron to test preliminary configurations and used to generate the general approach for applying QARTOD to Sairdron data.
- Data Accessibility: Once the data has been QC'ed, it will be ingested into an ERDDAP data server, which will provide access for global, near-real time data distribution as well as access by domain scientists for their research; Serving data via ERDDAP is a task being undertaken by project partners at NOAA PMEL using their existing services. During this performance period, Axiom developed a sample web application that can render data and quality control from standardized datasets to produce a simple time-series visualization that illustrates the QC results.

[An interactive application](#) demonstrating this capability was created to facilitate the generation and testing of QC configurations.

- Programming language: All code will be written in the Python programming language; All code was written in the Python programming language and contributed back to the [ioos_qc](#) library.

1.4.5.7. Optimizing Machine Learning Pipelines for Novel Biological Data Streams; Original Completion

Date: May 2020

Status: Complete.

- Optimize the existing proof-of-concept pipeline to better handle streaming datasets and transition to an efficient system; A streaming based system to ingest and process Imaging FlowCytobot (IFCB) datasets from multiple instruments which can be subsequently displayed in data portals has been implemented. The approach is sufficiently flexible to be applied to any type of dataset ingested into the Kafka-based system. The existing Random Forest classifier was replaced with a Convolutional Neural Network (CNN) model developed in Keras and deployed with Tensorflow Serving. The CNN models have been shown to exceed the accuracy of the Random Forest classifier and CNN models described in the literature.
- Develop a RESTful API that provides access to all data ingested by the system irrespective of data source; A streaming pipeline built up the industry standard Apache Kafka, Python-based Faust, and Tensorflow was developed in a sufficiently modular and flexible manner to support ingestion and analysis of any datatype. Access to the data is available to internal stream consumers or through API endpoints such as the [Axiom specific IFCB RESTful API](#).
- Support communities concerned with the proliferation of HABs and marine phytoplankton biodiversity through data and knowledge and technology transfer; Source code and documentation for data ingestion pipelines and processing will be made publicly available on GitHub at the [hydraulics repository](#). Similarly, the developed classification models and tools for each data type will be made publicly available at the repo.

1.5. Modeling, Analysis & Product Development Subsystem

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;** Original Completion Date: May 2020.
Status: Complete.
- **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 2020.
Status: Complete.

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.**
 - Publication of the Bulletin of American Meteorological Society Annual Report on the State of the Climate in 2018; Original Completion Date: June 2019.
Status: Completed.
 - Initiate update to web-based NOAA Arctic Report Card, with target completion date in December 2019; Original Completion Date: July 2019.
Status: Completed.
 - Complete the 2018 NOAA Arctic Report Card, in anticipation of public release during the 2019 American Geophysical Union Fall Meeting; Original completion date December 2019.
Status: Completed.

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 an improved shoreline database for the U.S. East and Gulf of Mexico coastal waters and floodplain that can be used by OceanMesh2D to generate more accurate meshes; Original completion date December 2019.
Status: Complete.
 - Refine the ability of OceanMesh2D to generate global meshes with a range of projections.; Original completion date December 2019.
Status: Complete.
 - Support a variety of projections in ADCIRC to support global models. Also improve the ability for ADCIRC to simulate high latitude regions; Original completion date December 2019.
Status: Complete.
 - Improve the ability to mesh thalwegs and deep channels embedded within shallower estuarine systems and onto continental shelves. This includes dredged channels; Original completion date January 2020.
Status: Complete.
 - Implement layered approach to incorporating bathymetry and topography such that a hierarchy of databases and DEM's can be iterated through to select values as per defined criteria within OceanMesh2D; Original completion date January 2020.
Status: Complete.
 - Improve parameter selection strategies to generate robust and efficient meshes and provide recommendations to NOAA; Original completion date March 2020.
Status: Complete.
 - 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 April 2020.
Status: Delayed. On track to complete by next reporting period.
 - Develop strategies to optimize upriver river meshing so that the meshes can be readily coupled to the National Water Model; Original completion date June 2020.
Status: Delayed. On track to complete by next reporting period.
 - Develop 1D mesh elements to be implemented in the OceanMesh2D code; Original completion date October 2020.
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 and begin conducting stakeholder interviews to determine data product priorities and assess availability of data.
- **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.**
 - 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.
 - Publish Bering Sea science status report; Original completion date May 2020.
Status: Complete. The report has been sent to the printers and will be mailed. The web version is being posted.
- **Subaward to Axiom Data Science to develop data products in the Alaska region to support**

the national Regional Ocean Data Sharing Initiative.

- Develop Bering Sea resource page on AOOS website with links to other resources; Original completion date May 2021.
Status: On track
- 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

1.6. Additional Activities and Successes Related to Mission

- Continued financial support for Alaska Harmful Algal Bloom Network was sought. Funding has been secured for next project year.
- Future support for the Shorezone program is also being pursued.

2.0 SCOPE OF WORK

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

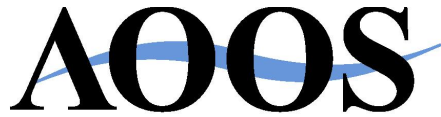
3.0 PERSONNEL AND ORGANIZATIONAL STRUCTURE

- McCammon gave notice to the full AOOS Board of her intent to step down as executive director later this year but stay on for a transition period as a part-time “Senior Advisor”. A search committee has been identified, with Ed Page as chair. A position announcement will be released in July. The goal is to have a replacement by late fall.
- AOOS hired Jill Prewitt as Regional Ocean Data Coordinator with funding from the new data sharing partnership initiative. She will be focusing on increasing access to Bering Sea data as her initial priority.

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
1	Hydroball® 0.50m-50 m Model	\$25,260



Alaska Ocean Observing System
1007 W. Third Avenue, Suite 100
Anchorage, AK 99501
www.aos.org

FROM: Molly McCammon, Executive Director
Alaska Ocean Observing System

RE: Report in response to Regional Ocean Partnership Special Award Conditions:
NA16NOS0120027

DATE: July 14, 2020

Background

The Alaska Ocean Observing System received funds in 2019 through the national IOOS Program for Regional Ocean Data Sharing Partnerships. The AOOS Board identified the rapid ecosystem change in the Bering Sea/Strait region as the focus for the initial two years of this funding. The 2019 goals were to increase regional data sharing among federal, state, community and private sector partners to facilitate stakeholder response to rapid ecosystem change in the Bering Sea, support agency management decision making, and enhance economic opportunities.

The Objectives for 2019-20 included:

1. Support coordination of regional data sharing among federal, academic, state and private partners;
2. Provide increased access and added value to Bering Sea data;
3. Develop a suite of Communication/outreach materials; and
4. Engage and communicate with Bering Sea communities, including input from the communities and sharing the results back.

Work Completed

The project was informally kicked off in December 2019 with a presentation to the AOOS Board on its goals and objectives. In addition, AOOS co-sponsored with the US Arctic Research Commission (USARC) and the North Pacific Research Board (NPRB) two workshops at the Alaska Marine Science Symposium (January 2020) and Alaska Forum on the Environment (February 2020) focused on the response to rapid ecosystem changes in the Bering Sea (Objective 1). These workshops included the information needs of various stakeholders to be able to respond to the changing environmental conditions. The workshop participants identified research

priorities, data and information gaps, pathways for improving science communication, firsthand changes and impacts to subsistence harvest and food security, and human health and safety concerns and extreme weather-related events. These recommendations are being used as preliminary input into the project.

AOOS hired a Regional Ocean Data Sharing Coordinator to coordinate the overall project (Objective 1). The Coordinator, Jill Prewitt, started with AOOS in April 2020. She has been working with other members of the team at Axiom Data Science and the University of Alaska Fairbanks International Arctic Research Center.

In May the team launched a project website and Facebook page (Objectives 2, 3 and 4). These have been used to give a general overview of the project, inform about upcoming activities, share information about the status of research in the Bering Sea in 2020 (especially in response to the covid-19 related cancellations of many agency and university research cruises), distribute the “Bering Science” report (see below), and solicit input from stakeholders on their data sharing needs.

The report “[Bering Science: Spring 2020 Bering Region Ocean Update](#)” was developed in collaboration with the University of Alaska’s International Arctic Research Center (IARC) and released in June (Objective 3). AOOS and IARC worked with over 20 agency and university scientists from across the region to compile information on a diversity of topics from sea ice and ocean acidification to birds, fish and marine mammals. The focus was on changes observed in 2019 in the northern Bering Sea, with some information about the southern and eastern Bering and the southern Chukchi. The spring 2020 publication, which was written for a general audience, is intended to be the first of several reports published annually.

Informal stakeholder meetings have been held via teleconference or webinars to solicit input on the data needs of various stakeholder groups in the Bering region (Objectives 2 and 4). Meetings were held with Bering Sea Crabbers Association, Bering Sea Fisheries Development Foundation, Ecosystem Conservation Office of the Aleut Community of St. Paul, Western Alaska Partnership (formerly LCC), Alaska Sea Grant Marine Advisory Program (Nome agent), and the Arctic Domain Awareness Center at UAF. Additional meetings are planned with other stakeholder groups such as other Alaska Sea Grant MAP agents, additional regional Tribal associations, etc.

Challenges

Plans for community-based in-person meetings (Objective 4) have been put on hold due to covid-19. These types of meetings are important in western Alaska where internet connections are often very slow, and face-to-face communication is important. Outreach efforts will continue through radio shows (scheduled for July 16 on KOTZ- Kotzebue radio station and July 31 on KNOM - Nome), newspaper articles, local partners (e.g. Alaska Sea Grant MAP agents), and other means of communication, but in-person community meetings will likely be delayed until 2021. Almost all in-person meetings and conferences in Alaska have either been cancelled, postponed, or switched to online formats.

Data Products

The Bering Sea Data Integration Portal (<https://bering-sea.portal.aoot.org/>) was launched in May (Objective 2), which provides direct access to datasets in the AOOT system including real-time sensor feeds, operational oceanographic and atmospheric models, satellite observations and GIS data sets that describe the biological, chemical and physical characteristics of the Bering Sea and its surrounding waters. We are working to ensure that the Data Portal contains all of the data that is currently available for the Bering Sea region. As we continue the project, we will identify any missing datasets and work to incorporate these into the Data Portal or provide links to them.

The plans for new data products are described below under “Future Continuation of the Work.”

Future Continuation of the Work

Data products

Ocean Acidification (Objective 2) - We are working with the [Alaska Ocean Acidification Network](#) (AOAN), supported by AOOT and other partners, to develop visualizations of ocean acidification (OA) data that can provide a synthesis of existing data and, if possible, OA forecasting in a way that is understandable and useful to stakeholders. With the AOAN, we are planning on holding a meeting with OA scientists and key consumers of OA data to discuss the existing data, and how it would be most helpful to display that information.

Harmful Algal Blooms (Objective 2) – Similarly, we are working with the [Alaska Harmful Algal Bloom Network](#) (AHAB) to develop visualizations of harmful algal bloom (HAB) data for researchers and stakeholders. HABs are an emerging issue in Alaska, both for wildlife and also human health and safety through subsistence harvesting of shellfish. AOOT has recently received funding to hire a full time AHAB coordinator and develop a statewide HAB action plan.

Vessel traffic and safety of marine operations (Objectives 2 and 4) – With the decrease in sea ice in Alaska waters and a longer open water period, an increase in vessel traffic through the Bering Strait is expected with potential socio-economic and environmental changes. A primary objective of this project is to develop data products for vessel traffic information, aiming at safety of marine operations in the Bering region. A first step is planning meetings with stakeholders in the Bering region on their data product needs for vessel traffic information and safety of marine operations. Stakeholders include coastal communities and tribes, the US Coast Guard and the Department of Homeland Security’s Arctic Domain Awareness Center, Marine Exchange of Alaska, representatives from Ports such as King Salmon, Bethel, Unalaska, Nome, Saint Paul, and the fishing and marine transportation communities.

Bering Strait Transboundary Oil Spill Response Tool (Objectives 2 and 4) – We are working with World Wildlife Fund’s Arctic and Russian Programs to develop an oil spill response tool for the Bering Strait region that would include both US and Russian waters. A Statement of Work is

being developed between WWF and AOOS on the scope of the project. First steps will include creating a data inventory of datasets available on both sides of the Strait. The data will include datasets from both Russia and Alaska, and will be accessible to the public, as well as to response authorities on both sides of the Strait in the event of an oil spill.

Access to Agency data (NOAA, USFWS, USGS, ADFG) Webpage (Objectives 1 and 2) - The AOOS Data Portal currently does not contain all relevant agency data relating to the Bering Sea. In many cases the data is already available through agency websites and data portals. Our goal now is to create an area within the Bering Sea Data Integration Portal that will contain links to all agency data in one location, rather than users needing to visit multiple sites. If there is interest from stakeholders (and an identified need) in making the data available on the portal, we will work with the agencies and our data manager, Axiom Data Science, to ingest the agency data into the AOOS system.

Agency Data Management Review (Objective 1) – we plan on conducting a review of agencies' data management capabilities to identify areas where there are issues with data availability.

Communication and Outreach Products (Objective 3) – Work has begun on reports for the fall 2020, and planning is underway for a spring 2021 report. The first fall report (planned for release on October 1) will include a synthesis of the spring sea-ice conditions during breakup, summer weather conditions, and any research results from agencies and academia that may be available (although most agency research has been cancelled for 2020). This report will be distributed electronically to stakeholders, especially participants in fall meetings such as Alaska Federation of Natives and the BIA Providers conference (whether held in-person or virtually). A longer report released in the late-fall/early winter will include community observations and additional research results from agencies and academia and will be distributed more widely. The spring report will be similar in content and distribution to the 2020 Bering Science report, with a summary of winter sea ice conditions and weather, further synthesis of research results from the previous year, and any early spring observations of physical and biological resources.

Year 2 Statement of Work and Budget – The team is working with our partners to develop a work plan and budget for the year 2 funding that will be received through the AOOS cooperative agreement with NOAA.

New Relationships Established

- Environmental Conservation Office, Aleut Community of Saint Paul Island – provided input to the Bering Science spring report, continued conversations about how AOOS can support community observations and produce data products.
- Alaska Conservation Foundation: Aleutian Bering Sea Initiative and Western Alaska Partnership (formerly Western Alaska LCC) – ongoing conversations about how AOOS can support community observations and produce data products.
- World Wildlife Fund (WWF) Arctic and Russian Programs – transboundary (US/Russian) data sharing with the development of the Bering Strait Oil Spill Response Tool.

- Alaska Fisheries Science Center – working with AFSC communications and scientists on development of the Bering Science spring report, radio shows and webinars.
- AK Center for Climate Assessment and Policy (ACCAP) – working with ACCAP to develop the communication and outreach products, including reports, radio shows, and webinars.