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, 2020 – May 31, 2021
Prepared by Sheyna Wisdom, Project PI on June 29, 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 April 28, 2021 to review the upcoming Board meeting, to review the recommendations of the Diversity, Equity, and Inclusion (DEI) Working Group, and to have an overall discussion on the roles of the new Executive Director, Sheyna Wisdom.
- The Board met on May 13, 2021. Board action items included changes to the Standard Operating Procedures and Memorandum of Understanding based on the recommendations of the DEI Working Group; acceptance of a new proposal funded by the World Wildlife Fund (WWF); extension of the Axiom contract until June 2026; approval of the conceptual plan for the FY21 spend plan and FY20 Y5 carryover funds; approval of the FY21 non-core funding spend plan; and discussion of ideas on how to spend the Regional Data Sharing Initiative funding.
- A final spend plan for FY21 core funding, Year 5 carryover funds, and funding for the Regional Data Sharing Initiative, Alaska Harmful Algal Bloom (AHAB) Network, and the Alaska Ocean Acidification Network (AK-OAN) was submitted and approved by the Executive Committee on June 24, 2021.
- Bi-monthly Executive Committee meetings with the Executive Director were established starting June 2021.
- AOOS will work with the DEI Working Group to develop new Board membership with Alaska Native organizations.

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

- Several meetings with the IOOS Program Office and the IOOS Association were held in February for the new Executive Director Wisdom to meet IOOS.
- A PI meeting was held in February 2021 for PIs to present their research to the new Executive Director Wisdom.
- A change in PI (from Molly McCammon to Wisdom) for the NOAA Cooperative Agreement was approved on March 19, 2021 by NOAA.
- A No-Cost-Extension (NCE) for Year 5 of the NOAA Cooperative Agreement was approved on March 24, 2021 extending the award until May 31, 2022.
- NCEs were awarded to all PIs that requested the extension.
- Executive Director Wisdom and Senior Advisor McCammon conducted annual evaluations for Holly Kent and Jill Prewitt.
- A final descope of the Year 1 funding award will be submitted to the IOOS Program Office in July. Subawards and contracts for Year 1 of our NOAA Cooperative Agreement are in development.
- AOOS continues to seek additional external funding, and in this reporting period, nine proposals were submitted; five were not awarded; and four are pending.

1.1.3. Support national and international partnerships and collaborations.

- McCammon sits on the IOOS Federal Advisory Committee (FAC), which met virtually in January and in June, as well as held several administrative calls. The FAC finalized a set of recommendations to the IOOS Program Office and the Interagency Ocean Observing

Committee relating to vision and strategy, requirements and partnerships.

- Wisdom and McCammon attended the annual spring IOOS meeting, held virtually, in March. They also participated in the IOOS Association's strategic planning sessions, as well as IOOS Association Public Policy calls.
- Wisdom represents AOOS in the Consortium for Ocean Leadership and participates in their member calls.
- McCammon is co-lead of the IARPC Environmental Intelligence Collaboration Team which is facilitating coordination of Arctic research cruises. AOOS is helping to maintain a monthly Arctic research cruise status report.
- McCammon sits on NOAA Science Advisory Board's Ecosystem Sciences Management Working Group (WG) which meets virtually every two months. The WG is now focusing on new reports on NOAA's Leadership role in Coastal Resilience, and in addressing needs for rapidly changing living marine resources.
- McCammon represent the Sustaining Arctic Observing Network (SAON) on the planning Task Force for an Arctic Action Plan as part of the upcoming UN Decade of Ocean Science (2021-2030). The plan is now finalized, and discussions are underway on how best to implement the plan.

1.1.4. Support Alaska and regional partnerships and collaborations.

- AOOS staff attended and hosted panels at the virtual Alaska Marine Science Symposium in January.
- AOOS staff continue to attend and co-host the Alaska Marine Policy Forum (AMPF) held every other month.
- Wisdom presented at the Alaska Eskimo Whaling Commission (AEWC) in February and will continue to attend their tri-annual conventions as possible to continue her long-standing relationship with this organization.
- Wisdom and McCammon met with the Alaska delegation staff in March to discuss AOOS and future funding opportunities.
- Wisdom sits on the Alaska Center for Climate Assessment and Policy's Advisory Committee and is participating in their bi-monthly meetings.
- Wisdom and McCammon participated in monthly meetings of NOAA's Alaska Regional Collaboration Team.
- Wisdom participated in the Kawarek Knowledge and Research Sovereignty Workshop in May 2021.
- See section 1.2.3 for activities relating to the AK-OAN, the HABON, and the Alaska Water Level Watch (AWLW). 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.

- Holly Kent launched the new AOOS website in February 2021.
- Kent continued to add content to the new 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 an e-newsletter in May to a list of over 2,000.

1.2.2. Support ongoing stakeholder interactions.

- AOOS continues to use the AK-OAN, the AHAB Network, the AWLW and other forums to engage with stakeholders. See section 1.2.3 for specific actions.

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

Alaska Ocean Acidification Network

- Darcy Dugan facilitated two meetings of the AK-OAN steering committee to keep track of

progress and identify new activities and objectives for the network, including participation in the drafting of a nationwide vulnerability assessment.

- Dugan continued writing and producing bi-monthly OA Network eNews, including articles about monitoring, research, outreach and scientist interviews, as well as maintaining the network website as a hub for OA information in Alaska.
- Dugan organized and facilitated a "CAN" meeting to communicate and coordinate between the six coastal acidification networks in the US. She also created an infographic for International OA Day of Action that was used by other OA networks across the country.
- Dugan hosted a researcher session at the Alaska Marine Science Symposium in January where 18 researchers provided updates on activities, results, and planned work. Dugan also organized a panel at the symposium titled "Multi-stressors in the marine environment: what do we know so far and how can it be used in management" attended by over 250 people.
- The network continued to organize, host, and/or publicize events related to OA in Alaska, including researcher talks at the Alaska Shellfish Grower's Association annual meeting and a National Fishermen panel titled "Alaska Salmon Fishermen on a Warming Planet: Adversity, Opportunity and Transition."
- Dugan took over the chairmanship of the OA Tribal monitoring working group, implementing monthly calls to address issues across regions and work with researchers and regional Tribal coordinators to identify and improve standards for sample analysis, data sharing and communication.
- The OA network co-hosted a mini symposium on ocean acidification and warming for crabbers in May with the Alaska Bering Sea Crabbers and the Bering Sea Fisheries Research Foundation. The session, which drew 50 people, included science presentations and dialogue with the industry, including ways crabbing vessels can contribute data.
- Dugan is working with Southern Dipper Productions on a short video about a NOAA OAP funded project looking at tipping points and salmon response to OA; expected release in June.
- Dugan is working with Network partners to develop an Alaska Seafood Climate Roundtable that would bring together leaders in the fishing industry to deepen their understanding of emerging policy initiatives surrounding CO2 emissions reduction, and provide a platform for dialogue, questions, and potential common ground on how the industry can support and benefit from the initiatives.

<u>Alaska Harmful Algal Bloom Network</u>

- Thomas Farrugia has continued to host monthly meetings with the entire AHAB Network and produce meeting notes from each meeting that are distributed throughout the network.
- Farrugia has also been maintaining and updating the AHAB website with recent news articles, events, job openings and funding opportunities related to HABs in Alaska.
- Farrugia conducted informal listening sessions with many of the AHAB network members to better understand their individual interests, efforts, activities in their regions, and to see how the AHAB network could be helpful to them.
- Farrugia has also actively sought out new network members, establishing connections and starting collaborative projects to provide members with support. There are now over 140 individuals from over 30 organizations that are part of the network.
- The AHAB Steering committee was reformed and met for 2 meetings (December 2020 and April 2021), led by Farrugia. These meetings helped define the role of the Coordinator as well as the Steering Committee and Working Groups within AHAB.
- As part of the establishment of the AHAB Network, Farrugia has been developing the AHAB Action Plan, as well as forming budgets and spend plans to meet the goals of the AHAB network and the national Harmful Algal Bloom Observing Network (HABON).

- Farrugia has formed 2 working groups that will take on specific tasks to further the goals of the AHAB network: the HAB Lab working group and the HAB Event Coordination working group. More working groups will be formed in 2021 and 2022.
- Farrugia has also been working on producing the 2020 AHAB summary - which details all the HAB sampling efforts in Alaska in 2020. This will be an annual report that will help track the growth of the HAB sampling effort in Alaska.
- Working with Axiom, Farrugia has put together a plan to develop the HAB data portal, which will start by providing a map of past and current sampling locations for HABs in Alaska. This is in response to AHAB network members who were unsure where there was appropriate coverage and where there were gaps in HAB sampling.
- Farrugia has presented on HABs at a variety of meetings and conferences, including to the Alaska Fisheries Science Center, Kachemak Bay Science Conference, and OneHealth Group.
- In collaboration with the US Fish and Wildlife Service, Farrugia has also been working on starting a sampling program for HABs in freshwater lakes in Interior Alaska
- Farrugia has also been part of two project proposal submissions involving HABs: one was in response to NOAA's grant opportunity "Addressing the Impacts of Multiple Stressors on Shellfish Aquaculture through Research/Industry Partnerships", and the other was in response to Alaska Sea Grant's announcement for funding opportunity for 2022-2024.

Alaska Water Level Watch

- The AWLW Steering Committee has been formed and is made up of a team consisting of state and federal agencies, local governing entities, non-profits, private businesses and communities.
- The AWLW 2020-2025 Guidance Plan outlining the AWLW organizational vision and mission as well as the water level build out approach for Alaska has been finalized and sent to the AWLW Steering Committee for approval (June 2021).
- An online catalog of water level activities is maintained by the Alaska Department of Natural Resources (AKDNR-DGGS) and is shown in the AWLW Build Out documents and maps.
- Janzen presented on the AWLW Data Portal at the AGU Ocean Sciences 2020 meeting, "Building Data Access for Sharing Non-NWLON Water Level Information in Alaska."
- 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 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 AMPF in February, and April.

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 was held virtually in January 2021. AOOS staff hosted several panels and served as judges for the student poster/presentations.

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

1.3.1.2. Increase access to weather observations using AIS.

- **Subaward to the Marine Exchange of Alaska to increase access to Weather Observations using AIS.**
  - Install new weather sensors at Cape Spencer; Original completion date: May 2021.
    Status: Delayed - Site survey completed, equipment purchased. Installation planned for June 2021.
  - 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. On May 26, 2021, the buoy separated from its mooring. AOOS and Coastal Data Information Program (CDIP) are working to replace the mooring and buoy at this location by mid- to late-July 2021. We are currently investigating the cause of the drift.

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

- **Subaward to University of Alaska Fairbanks (UAF) to support operation and maintenance of three HFR sites on the Chukchi and Beaufort Seas.**
  - Winterize systems to combat wear and tear on equipment; Original Completion Date December 2020 to January 2021.
    Status: Complete. COVID-19 travel restrictions prohibited a winterization trip, but UIC Science in Utqiagvik visited the sites at Cape Simpson and Point Barrow in our absence. They retrieved the data computer from each site and shipped them to the University of Alaska Fairbanks, and reported back on equipment/hardware status, which unfortunately included broken wind turbines at both sites.
  - Maintenance trip to repair systems on the North Slope; Original Completion Date April 2021.
    Status: Complete. This trip was not listed as a milestone in our scope of work, but with all the field work delays, as soon as COVID travel restrictions lifted for Utqiaġvik, a maintenance trip was planned and executed. Many repairs were warranted. Wind turbine replacements were needed at both sites; a new coaxial connector was needed on the transmit antenna at Point Barrow, and a replacement receive antenna dome and satellite communications were needed at Cape Simpson. After all repairs were successfully completed, antenna calibrations were performed at both sites. The sites are now operational and ready for the 2021 ice-free season.

1.3.1.5. Install three new high frequency radar field sites in the Bering Strait.

- **Subaward to UAF to install three new HFR field sites in the Bering Strait Region.**
  - 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 and believe it has been completed, but due to COVID travel restrictions, we have not been able to verify this is so. We have a request into the corporation for travel access, as well as for local hire assistance.
  - Operate and maintain HFR sites in Wales and Shishmaref, Alaska; Original completion date: September 2020 – May 2021.
    Status: Delayed – Michael Ahkinga Sr. is still on board to help operate and maintain the site in Wales. We have a solution for the internet connectivity issues in Wales by using a HughesNet system in place of the GCI WiFi. Please see the previous bullet about a power source for the Shishmaref system. Solutions for both have been on hold due to COVID-19 travel restrictions, but COVID restrictions are slowly lifting, and we have requested access to both sites. Additionally, plans are in motion for the new remote power location up the coast from Wales. We have surveyed the coastline, picked out

suitable locations, researched logistics, and have quotations for shipping needed equipment to Nome and then on to the remote location. We have a pending request for permission to set up on Wales Native Corporation land and are awaiting their board meeting where our request will be considered.

- Fabricate Remote Power Module (RPM) Lite; Original Completion Date: May 2020.
  Status: Delayed – Construction of the new RPM Lite by APRS World, LLC was delayed due to COVID-19, but fabrication is now underway with delivery to Fairbanks expected in late summer.
- Conduct field test of the RPM Lite low power remote power system; Original Completion Date: April – May 2021.
  Status: Delayed – Please see previous bullet. We now plan to test the RPM Lite in fall/winter 2021, after delivery of the RPM Lite system.

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

- **Subaward to UAF to upgrade two out-of-date HFR systems.**
  - Receive modernized equipment, antennas, and cables from CODAR Ocean Sensors; Original Completion Date: March 2021;
    Status: Complete – After minimal manufacturing delays due to COVID work restrictions, the refurbished HFR systems were received by UAF from CODAR Ocean Sensors in May 2021.

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.
    Status: delayed.
  - Sensors at Kotzebue (iRadar), Deering (iGage), Dillingham (iRadar), and Nelson Lagoon (iGage) are not currently reporting. Plans have been made for the Dillingham sensor installation to be taken on by JOA Surveys, LLC using different equipment. DGGS has completed logistical preparations to replace the iGage at Deering and fix or replace the iRadar at Kotzebue, which is scheduled for June 2021. A replacement iGage was sent to Nelson Lagoon via UPS and was lost in the mail. Another replacement sensor has been sent to Anchorage which will be taken to Nelson Lagoon with UAF travelers in fall 2021.
    Status: Complete.
  - DGGS submitted metadata for the Tununak station to Axiom Data Science.
    Status: complete.
  - The Homer water level sensor installed in July 2020 is currently reporting, although the sensor does not detect the lowest water levels. DGGS will test the current sensor at Kotzebue, which is not operating and likely replace it with plans to replace it with the sensor from Dillingham while the Kotzebue sensor is sent to the supplier for repair.
    Status: complete.
  - Additional water level sensors were purchased from Stillwater Technologies, LLC and Hohonu. These sensors are either cell or satellite-enabled and establish an inventory of available sensors for opportunistic travel to priority sites through other project funds or partner deployments. These new sensors are slated for Kwigillingok (prior sensor purchased for this site was installed in Homer July 2020) and Whittier. Installation plans are developing.
    Status: complete.
  - Since both Deering and Kotzebue require maintenance, travel and personnel service costs that were originally allocated to installing or maintaining sensors in Whittier and

Kwigillingok must be re-allocated. Installation at these sites will either be incorporated into future agreements with AOOS, through opportunistic travel, or partner travel. DGGS travel to Kwigillingok is anticipated in August 2021 through a National Fish & Wildlife Grant. DGGS plans to re-install an iGage during that site visit as an opportunistic deployment. The FY20 Milestone to deploy a Judd sensor in Whittier in December 2020 has been postponed.
Status: installation Delayed and Postponed

- State database for coastal storm flood documentation, to make storm-by-storm updates to an online database and to document new events that occur in 2019-20 storm season.
  Status: on track.
- DGGS continues work to update the DGGS catalog of historical storm events (http://maps.dggs.alaska.gov/photodb/#show=96&search=storm). An undergraduate intern was hired to make additional progress on this milestone, including adding photos from 2019 and 2020 storm seasons. DGGS completed a final review of the statement of work for phase III of Axiom's project on integrating high water marks into the Alaska Water Level Watch data portal.
  Status: on track.
- DGGS is considering a different method for publishing the original flood staff position information (i.e. surveyed elevation of the staffs) along with examples of their use during flood events., through the AWLW Data Portal (in phase III) and an ArcGIS story map.
  Status: discontinued.
- DGGS finalized a report on methods to evaluate coastal flood vulnerability to Alaska communities. In addition to the summary report, community reports and maps were published for Golovin and Hooper Bay. Available at https://dggs.alaska.gov/pubs/id/30573.
  Status: complete.
- DGGS completed work and published the community report and flood map series for Nunam Iqua (available at the same link above). Work is ongoing for Shaktoolik.
  Status: on track.
- Inform the National Weather Service (NWS) of potential flood impacts in advance of storm events. No major storms were tracked during this reporting period
  Status: on track.
- No major storms were tracked during this reporting period.
  Status: on track.
- Maintain AWLW Webpage content.
  Status: on track.
- DGGS maintains the online data catalog of water level activities shown in the AWLW Build Out map, updates were made to the catalog throughout this reporting period.
  Status: on track.
- Train NWS and SEOC to use coastal flood mapping products.
  Status: on track.
- DGGS did not present to the Alaska NWS during this period.
  Status: on track.
- DGGS did not present to the State Emergency Operations Center this reporting period.
  Status: on track.
- Conference and meeting attendance for discussions on water level sensors and deployments.
  Status: complete. (Note: This work is completed annually)

- DGGS finalized the AWLW 2020-2025 guidance plan and associated build out map and sent to the steering committee, a follow up meeting is being scheduled for June 2021. Status: on track.
- DGGS worked with the USGS and Kawerak to develop a proposal for inundation mapping using USGS modelled scenarios (this work was completed with State of Alaska funds).
  Status: on track.
- Monitoring coastal hazard conditions with near real-time camera systems.
  Status: delayed. DGGS researched and procured two types of remote camera monitoring systems to test throughout the summer of 2021 and into the fall storm season. A cell-enabled camera and mounting system was purchased from Nupoint as the high-end camera option. A security camera was purchased from Reolink as a cheaper option. The Reolink camera will not operate in very cold weather, so installation preparation includes coordination with the local tribe so that the camera operates during the open water and storm season, but is stored over winter. The Nupoint camera is slated for installation at Shaktoolik in September 2021, while the Reolink camera is not yet slated.
  Status: delayed.

- **Contracts to JOA Surveys and ASTRA to install water level instrumentation at Utqiaġvik, Alaska.**
  Status: Delayed. Contracts in place, travel restrictions from covid-19 have delayed installation. In May 2021, AOOS received permission to install the water level system as long as those entering the community are vaccinated. JOA Surveys will be performing a reconnaissance visit to the site of the installation in early July 2021, to identify any hardware needs for the installation. ASTRA and JOA surveys will then schedule an installation later in the summer (July - August 2021) to complete this installation.
- **Contract to ASTRA to operationalize codes that process GNSS observations to extract water level measurements.**
  Status: Complete. ASTRA provided the code for St. Michaels and Cape Spencer UNAVCO operated GNSS-r water level conversion to Axiom in February 2021, and submitted a report on the station data and data quality factors. Axiom has been working with ASTRA on the code integration to make it so Axiom can ingest UNAVCO data directly for these locations and convert the satellite data into water levels for display on the AWLW data portal. The station data are posted and undergoing quality assurance review in June, for final release in July 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. A buoy and mooring replacement are being shipped to Nome, Alaska and are expected to arrive in July 2021. Nome partners are standing by to deploy the buoy once it arrives.
- **Support operations and maintenance for the NREL owned Kodiak CDIP buoy;** Original Completion Date: May 2021.
  Status: On track. There has been no need to visit this mooring during this reporting period. Plans will being made for the buoy recovery either in the fall of 2021 or the spring of 2022, depending on the battery endurance left for this buoy that was deployed in 2019. AOOS received an extension on the buoy loan from NREL in 2020 through the summer of 2022.

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: Complete. The strategist position is expected to end in spring 2021.
- Wisdom represents AOOS on the AMEC Coastal Mapping Subcommittee, which meets monthly. 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.**
    - No stations were serviced during the reporting period. 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, with Phase III underway using AOOS internal funds.
    - Ingest planned Tier B and C water level station data; Original completion date: May 2021.
      Status: Complete, with new data ingestion ongoing.

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: Complete.
    - Continue updates of project website; Original Completion Date: March 2021.
      Status: On track.
    - Monitor incoming data (ongoing)**;** Original Completion Date: May 2021.
      Status: Complete.
    - Preparations for 2021 mooring turnarounds; Original Completion Date: May 2021.
      Status: Complete.
- **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.**
    - Add sensors to CEO and GEO moorings; Original completion date: March 2021.
      Status: Complete.
    - 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: Complete.
    - 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.
    - Purchase requisition delivered to Sea-Bird for procurement of three SeaFET v2.0 instruments (with biofouling Guard): Original completion date: March 2020;
      Status: Delayed. - PO in progress with Sea-Bird; Due to internal QA/QC issues between Sea-Bird and Honeywell (the supplier of a critical component required to assemble SeaFETs), the availability of new SeaFETs was delayed six months. A purchase requisition for three SeaFET v2.0 has been initiated with Sea-Bird.
    - *SeaFETs received from Sea-Bird.* Original completion date: March 2021;
      Status: Status: Delayed until July 2021.
    - *Field test all three SeaFET v2.0s prior to August deployment in the Beaufort Sea.*
      Original completion date: May 2021;
      Status: Delayed until July/August 2021. Field tests will be conducted in Stefansson Sound prior to deployment in August 2021.

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 2021.
      Status: Complete.
    - Deploy glider in southern Chukchi Sea using ship of opportunity; Original Completion Date: July 2021.
      Status: On Track. - The fully tested whale glider serial number 595 was delivered to the vessel Norseman II on May 28 for loading onto Rebecca Woodgate's Bering Strait cruise.
    - At sea data collection. Maintain website with real time acoustic detections and oceanographic data; Original Completion Date: October 2021.
      Status: On Track - We anticipate an early July deployment of the whale glider in the Bering Strait region.
    - Glider recovered, acoustic and oceanographic data downloaded; Original Completion Date: October 2021.
      Status: On Track - Upon recovery of the glider, oceanographic and acoustic data will be downloaded and QA/QCd prior to submission to the NOAA GliderDAC. The acoustic data will be converted to hourly wav files and will be examined for complete marine mammal detections.
    - 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: Complete.
- Glider pilot training; Original Completion Date: May 2021.
  Status: On Track - Logistics in the COVID period precluded safe and cost-effective travel for in-person trainings run by Webb. In order to deepen our pool of glider pilots to support missions in 2021, we developed an in-house training seminar series. We will re-assess our factory training options in fall 2021 once the threat of COVID spread is reduced and travel restrictions are reduced.
- Two Alaska region glider deployments; Original Completion Date: December 2020.
  Status: Complete.
- Development of EAFM Indices; Original Completion Date: May 2021.
  Status: Delayed - Held a planning meeting with Axiom personnel. We are on-track for a field demonstration of an Ecometrics Dashboard in conjunction with a Resurrection Bay glider mission in late summer 2021. We are working toward providing a measure of environmental anomalies based on use of the World Ocean Atlas monthly gridded hydrographic datasets.

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

- **Subaward to University of Alaska Fairbanks 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: Complete - The UAF owned Teledyne Slocum Glider serial number 507 has had significant upgrades done to it over the last 6 months. These include a new high displacement buoyancy pump, a new thruster, a new forward science compartment with the Simrad WBT Mini and Odroid processor and a new flooded science bay that encapsulates the ES200 split beam transducer.
  - Odroid and glider software upgrades; Original completion date: December 2020.
    Status: Delayed - Glider has just arrived at UAF (June 4, 2021). All hardware connections have been verified but additional software development of the python code to trigger the echocounder, process relevant data fields and send echo-metric data files to the glider science computer has been delayed. Much of the additional integration work is pending the input from a UW programmer.
  - Project website and *Ecometrics Dashboard* app version 1 developed; Original completion date: December 2020.
    Status: On track - Meeting with Axiom programmers has kicked off development of the UI Ecometrics Dashboard.
  - Tank test and field test in Resurrection Bay; Original completion date: January 2021.
    Status: Delayed - Anticipate sea trials in summer 2021
  - 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: On Track.
- **Subaward to Axiom Data Science to expand the sampling capability of a Slocum autonomous underwater glider to provide in-situ ecosystem monitoring.**
  - Make real-time and post-processed glider data accessible through the AOOS data portal; Original Completion Date: May 2021
    Status: On Track - The UAF glider Shackelton was deployed for three flights in Prince

William Sound to collect oceanographic data and listen for herring tagged by the EVOSTC Herring Research and Monitoring Program. This trial project, in collaboration with the GulfWatch Alaska and Herring Research & Monitoring program, is looking at the feasibility of using gliders to detect tagged herring as part of the AOOS Ecosystem Assessment for Fisheries Management glider project. Data were made available in real-time through the AOOS data portal at this link, in addition to submitted to the IOOS Glider DAC.

- Provide technical support for data formatting and metadata creation to ensure data products are submitted to IOOS Glider DAC; Original Completion Date: May 2021.
  Status: On Track - During this performance period, Axiom has been providing data management support to the UAF team for standardization of glider data to the IOOS DAC requirements and for real-time streaming through the AOOS Ocean Data Explorer. This project leverages the SECOORA/GUTILS package for reading, merging, and post processing Slocum Glider deployed in Prince William Sound during its first mission in January 2021. In anticipation of that deployment, Axiom has gained access to the Teledyne Webb Research SFMC dockserver and confirmed rsync capability with the data folder(s). Additionally, Axiom provided technical support for the configuration of the instrument to the JSON file format, which includes the metadata required for submitting and serving data via the IOOS Glider DAC.
- Develop Ecometrics dashboard to expose past and current environmental conditions along the glide path; Original Completion Date: May 2021.
  Status: On Track - Axiom worked with project partners on a mock-up of the Ecometrics dashboard. Elements of the dashboard will include:
  1. Meters to indicate current conditions (low/normal/high)
  2. 2-D Plan View map showing trackline with data
  3. Time series
  4. Profiles
  5. 3-D Map of data.
  6. Acknowledgements and metadata section.

  Comments and feedback were received from partners on the initial mock-up, which will undergo another round of revisions prior to arriving at a final draft version that will inform the front and backend application development.

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: Delayed - The plan to collect and analyze samples as part of the Bering Arctic Subarctic Integrated Survey (BASIS) survey cruise was canceled due to COVID-19. Because NMFS research cruises only take place in even-numbered years, this work will be picked up again in Summer 2022. Under a normal timeline, we would analyze the samples during the year following the field work (Fall 2022 – Summer 2023) and finalize and archive the data before two years had passed (Summer 2024). Currently, a No Cost Extension (NCE) has been approved by AOOS/IOOS/NOAA for this project until March 2022. We would like to request an additional NCE until at least March 2023. We anticipate that the samples may be analyzed by this date, but it is unlikely that the finalized data will be publicly archived by this date.

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.**

- Clean conductivity sensor at Cordova tide station; Original Completion Date: December 2020.
  Status: Complete December 2020
- Upload data from OTN array; Original Completion Date: February 2021
  Status: Complete February 2021
- Submit data to OTN, upload PWSSC data to PWSSC historical data workspace; Original Completion Date: March 2021.
  Status: Complete May 2021
- Clean conductivity sensor at Cordova tide station; Original Completion Date: March 2021.
  Status: Complete March 2021
- Send conductivity sensor for calibration; Original Completion Date: April 2021
  Status: Completed May 2021

- **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 and middle portion of along-bay transect; Original Completion Date: May 2021.
    Status: December 2020 to May 2021 surveys were completed. We continue to leverage support from NCCOS and EVOSTC to enable monthly along-estuary sampling, in addition to cross-bay sampling.
  - 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 2021.
    Status: Complete for period. Conducted two seasonal cross-bay surveys on outer Kachemak Bay transect in February and April 2021 (one extra).
  - Deliver quality assured/quality controlled oceanographic data to AOOS data contractor Axiom within 6 months; Original Completion Date: May 2021.
    Status: Complete for period. QA/QC'd oceanographic data from the Kachemak Bay surveys through October 2020 (note: no sampling in November 2020 due to poor weather) have been provided to Axiom via the Research Workspace.
  - Present oceanographic and nutrient monitoring results at one or more science conferences annually (Alaska Marine Science Symposium or other); Original Completion Date: May 2021.
    Status: Complete. Kachemak Bay oceanographic sampling results were presented at the virtual Alaska Marine Science Conference in January 2021 and at the triennial, virtual Kachemak Bay Science Conference in March 2021.
  - Deliver oceanographic data and metadata to other NOS offices, BOEM and other agencies and stakeholders (on request).
    Status: Ongoing. Kachemak Bay oceanographic data were used by the US Fish and Wildlife Service (two offices) and Alaska Department of Fish and Game as part of their proposal development process to the Exxon Valdez Oil Spill Trustee Council FY22-31 funding opportunity during this period.

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: Complete.
    - Assess the potential for adding new indicators, such as harbor usage rate, oil spill response capacity, ocean health index, living resources assessment, shipping and vessel traffic change over time visualizations, etc.; Original completion date May 2021.
      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.**
    - This project has been completed.
- **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.**
      This project has been completed.

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.**
  Status: Delayed
  This cruise was originally planned to sample the entire Gulf of Alaska in summer 2019 (Figure 1) but was postponed due to the 2019 Federal shutdown delaying funds to secure a research vessel. Due to the lack of vessels available for a gulf-wide cruise in 2020, plans were pared down to only include observations in southeast Alaska (Figure 2). The revised cruise plans were canceled due to COVID-19.We are currently planning to execute this cruise in summer 2022. Under a normal timeline, we would analyze the samples during the year following the field work (Fall 2022 – Summer 2023) and finalize and archive the data before two years had passed (Summer 2024). Currently, a No Cost Extension (NCE) has been approved by AOOS/IOOS/NOAA for this project until March 2022. We would like to request an additional NCE until at least March 2023. We anticipate that the samples may be analyzed by this date, but it is unlikely that the finalized data will be publicly archived by this date.
- **Subaward to Rutgers University to assess pH and Plankton in the Gulf of Alaska**; Original Completion Date: May 2021.
  - Prep glider for deployment. This includes calibration of sensors, glider ballasting, and packing for shipment; Original completion Date: Mar 2021
    Status: On Track.
  - Ship glider to deployment location in Southeast Gulf of Alaska, final preparations for deployment (specifically re-condition the pH/CTD sensor after shipment); Original completion Date: Apr 2021)
    Status: On Track
  - Deploy vertically-profiling glider in Southeast Gulf of Alaska (either 1 long transect or two shorter transects, still TBD); Original Completion Date: September 2021.
    Status: On Track
  - Perform data quality control; Service sensors if needed; Original completion date: Dec 2021.
    Status: On Track
  - Glider data processing, analysis, and management; begin figure preparation, presentations, manuscript writing; Original completion date: May 2022.
    Status: On Track
- **Subaward to Hakai Institute to operate and maintain the ocean acidification instrumentation onboard the Alaska Marine Highway ferry Columbia**.
  This project has been completed.
- **Subaward to the Sitka Tribe of Alaska/ Southeast Alaska Tribal Ocean Research Network (SEATOR) to support the Indigenous led baseline ocean acidification data collection and monitoring efforts.**
  - Purchase supplies for the discrete sample kits to be distributed to SEATOR Partners; Original completion date: September 2020.
    Status: Complete.
  - Build and distribute discrete sample kits for SEATOR Partners; Original completion date: October 2020.
    Status: Complete.
  - Run discrete sample analysis on SEATOR partner samples; Original completion date: May 2021.
    Status: Delayed. STAERL staff spent most of 2020 working from home due to COVID and were unable to analyze samples. Additionally, STAERL has been short staffed since April-2021, resulting in additional delay.

- As needed contractual service with Schmolk Mechanical; Original completion date: May 2021.
  Status: Delayed. STA just opened their offices to contractors on June 1, 2021.
- As needed consumable and replacement part replacement; Original completion date: May 2021.
  Status: On track.

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

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: Some activities delayed due to covid. Now on track to be completed May 2022.

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 other outreach activities are underway. On track for completion.
- **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: Delayed due to covid.
  - Maintain and enhance the AHAB data portal for visualization and public access to HAB data and data products; Original completion date: May2021.
    Status: Delayed due to covid.
  - 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: Delayed due to covid.
  - Submit final datasets, data products, and metadata to the NOAA NCEI repository for long-term preservation; Original completion date: May 2021.
    Status: Delayed due to covid.

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**.

- Support equipment maintenance and turnaround for OA surface mooring at GAKOA
  Original Completion Date: Ongoing
  Status: On Track. The GAKOA surface mooring (outside Seward, AK) was successfully turned around in March 2021.
- Support equipment maintenance and turnaround for OA surface mooring at M2. Original Completion Date: Ongoing
  Status: On Track. The M2 surface mooring (southeastern Bering Sea) was successfully deployed in May 2021.
- Delivery of updated database links to AOOS for inclusion in AOOS data portal; Original Completion Date: Ongoing
  Status: Completed. All data collected through January 2020 have been archived and are publicly available.

1.3.5. Streamline access to Observations

FY19: AOOS received $75k to help fill gaps and streamline access to ocean observations. Original Completion Date: June 2019. Some of the funds are used to develop the Tiered Water Level Data Portal (see section 1.3.2.5). The remaining 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. Due to covid-19 travel restrictions in rural Alaska, funds were used to update and add AIS/weather stations in southeast Alaska. Funds for the coming year will now be used for northwest Alaska sites instead of southeast AK as originally planned.
Status: Complete.
FY20: AOOS received $75k to help fill gaps and streamline access to ocean observations. Intended use to deploy NWLON-lite water level station in Dillingham. Original Completion Date: Fall 2020.
Status: Delayed due to COVID-19 travel restrictions, but with no cost extension, will be completed in summer 2021.

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 new server builds in the data center, including: ordering parts, testing hardware builds, and resolving technical issues. A new Machine Learning Cluster was procured, including 4 V100's, 24K CUDA Cores and 5K Tensor Cores. Further, Axiom installed 600+ hard drives and 13 storage chassis for a next phase of storage expansion, and a new version of server boot manager for increased stability and flexibility was implemented. Technical scoping and experimentation was also done with new storage technologies (Ceph, using S3 compt APIs more) for system optimization.
  Status: Complete.

1.4.1.2. Data Portal Development.

- Axiom released version 2.13 of the data portal on December 8, 2020. This release version features improvements to time slider performance, including brush selection for time series charts and introduces a user timezone selector. Enhancements were made to the data download UX to allow users to queue multiple datasets for download, add datasets to a download ‘shopping cart’, and share download compilations with other users. For applicable portals, custom draw and measuring tools are available in the main portal map. Additionally, users can add annotations to the map view and print the image to a pdf for integration in presentations and reports. Frontend and backend work occurred to develop features for the next version 2.14 release, scheduled for late June 2021. This work includes: symbology changes to sensor layer for better contrast with lighter base layers (OpenStreet Map), user settings for color bar management, user settings for coordinate management, and print charts and data views as jpg file.Status: Complete.

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

- During this performance period, basic QARTOD tests were applied for 539 historical and real-time sensors that are accessible through the AOOS data portal. 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 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 originally merged into the ioos_qc library in December 2020, were modified and the ioos_glider submodule was replaced with the updated ioos_argo submodule. 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. Axion 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 contributed discussion topics and presentations suggestions in the pre-planning for the 2021 DMAC Virtual Annual Meeting to be held June 15-17, 2021. Axiom will be giving four oral presentations at the meeting, including presentations onL SanctSound acoustic data observing systems (Brian Stone, co-presenting with Carrie Wall Bell, NCEI); ATN DAC: Quality Controlled Animal Bourne Ocean Profiles on the GTS (Kyle Wilcox); Faster Visualizations of Gridded Data (Luke Cambpbell); and IOOS ERDDAP Implementation Status - GTS/Sensor Map Transition (Micah Wengren and Shane St.Savage).
  - Axiom Data Science also participated in the following regionally and national relevant DMAC meetings:
  - Seaweed Farm Start-up Training Program - February 2021
  - Pacific Environment data portal demonstration - April 2021
  - Exxon Valdez Oil Spill Trustee Council (EVOSTC) GulfWatch Alaska and Herring Program PI meetings - May 2021

  Status: Complete.

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

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

  Status: Complete.

1.4.3. Develop and maintain special data products

1.4.3.1. Support existing data products.

Activities completed to support existing data products included:

- rebuilt the NWS Alaska Sea Ice program ingestor package into a packrat framework and migrated codebase to Python into a importer container to ensure continuous data integration in the v2 data portal system

- resolved technical issues and data download using the virtual sensor for the Gulf of Alaska Hydrology Model in order to deliver data to end user
- worked with data provider to adjust QC parameter flags for Hakai Institute BoL stations to display post-calibrated and quality-controlled data
- responded to bug fixes and making other ease-of-use improvements to datasets, including updating portal tags and exposing additional metadata for platform (i.e. mobile) instruments.

Status: Complete.

1.4.3.2. Ingest new datasets and metadata.

Activities completed to ingest new data and metadata included:

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

Status: Complete.

1.4.3.3. Develop new data products.

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

Status: Complete.

1.4.4. Host and Support AOOS Website

1.4.4.1. Host and maintain the AOOS web portal.

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

Status: Complete

1.4.4.2. Provide access to data portal through website.

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

Status: Complete.

1.4.5. Support national IOOS Program data management activities

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

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

Status: On-track

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

- **Defining High-Level Feature Roadmaps (5%):** IOOS has spent the past two years investigating ERDDAP as the new recommended data access service for in-situ

observations. ERDDAP's broad use in the community, robust APIs, and simple interface make it an attractive solution to improve accessibility and re-use of IOOS RA datasets. To implement this project, Axiom created a document entitled IOOS Environmental Sensor Map: FY19 ERDDAP RoadMap that outlines the release approach and timelines that were maintained throughout the project.

- **Release Planning and Management (10%):** A primary motivation for a new release of the ERDDAP service and v1.2 IOOS Metadata Profile is to ensure consistent dataset structure across RA ERDDAP servers, so that national partners can harvest data via a single process. Throughout the performance period, Axiom met at bi-monthly intervals to track development progress and coordinate project communications across IOOS RAs and NDBC. Axiom presented on the status of the ERDDAP transition project and guidelines at the October 2020 and the upcoming June 2021 virtual DMAC Meetings.
- **Development & Implementation (40%)**:
  The IOOS Metadata profile is a compound profile that builds off of the NOAA NCEI NetCDF Templates, which in turn build off of the Attribute Convention for Data Discovery (ACDD) and Climate and Forecast (CF) Conventions. Axiom worked with the IOOS Program Office to implement Version 1.2 of the IOOS Metadata profile that incorporates feedback from the IOOS community, 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 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, as per the Requirements for GTS Section in the IOOS Metadata Profile. Effective January 2021, NDBC began ingesting data streams from AOOS, SECOORA, and CeNCOOS via ERDDAP for insertion into the GTS.
- **Improved User Documentation (15%):** As listed in task 1.c (above), user documentation was updated for:
  - IOOS Metadata Profile version 1.2
  - QARTOD guidelines using the CF ancillary variables approach
  - 'Gold standard' ERDDAP configuration documentation, with datasets compliant with IOOS Metadata Profile 1.2

- **Establishment of Test Environments and Test Datasets (10%):** To assist RAs or others in the community who are setting up ERDDAP for the first time, Axiom created a "Gold Standard" server with examples that follow the v1.2 Metadata Profile and QARTOD and GTS ingest standards. This ERDDAP server is live at standards.sensors.ioos.us and the setup is available in a GitHub repository. This environment was created to support users working in this repository as a starting point for their own ERDDAP setup.

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

  Status: On-track

  - **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 2.14 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 time series charts

    In March 2020, 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/. During this performance period, the submodules were updated to include additional qc tests as follows:
    - Integration of ioos_qc.argo module
      - test suite: Pressure Increasing Test, Speed Test
    - Merge glider module into new argo module

    During the performance period, approximately 85 new real-time sensors were added to the Environmental Sensor Map from observing systems across the IOOS enterprise. In FY20, 2,055 real-time stations or station updates were made to the Environmental Sensor Map. 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 10, 2020):
    - All stations (includes both historic and real-time stations, across the entire globe):
      - 40,472 stations
      - 125 data sources across 273 affiliates
      - 312 unique parameters

- Real-time stations ("real-time" stations have data from the past week):
    - 28,613 stations with observations in the past week, across 79 data sources
    - Approximately 64,900 sensors with observations in the past week
    - Approximately 42,454,000 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/.

1.4.5.2. MBON Data Portal

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

  Status: On-track
    - 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.

- **Task 2. Scoping and build-out of MBON and ATN portal integration.**
  Status: On-track
  A prototype instance was developed for users to overlay animal movement tracks with physical environmental and biological data sets in the ATN or MBON data portal maps. With this capability users are able to: i)explore data spatially and temporally (i.e., using the time slider playback), ii) browse to adjacent environment or biodiversity data nearby animal locations, and iii) download data or access it through interoperability end points for analysis. The instance is undergoing review and feedback by the ATN Coordinator and ATN Program Managersready for testing. Next steps include developing flexible data publication linkages needed to represent animal tagging projects in multiple catalogs/portals outside of its native environment (i.e., the MBON data portal).
- **Task 3. Load and visualize more data.**
  Status: On-track
  The MBON data portal was kept current with the latest versions of biodiversity observations data that was shared among program stakeholders. Axiom worked with CariCOOS and Abigail Benson to make revisions to the Puerto Rico Long-Term Coral Reef Monitoring Program Database Compilation (1999-2019) dataset (accessible from OBIS/GBIF) into the MBON data system. 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 ingest and standardize seven biodiversity datasets from the Reef Check CA program, one fish abundance dataset from the CCFRP program, and standardize over 10 years of CTD and nutrient time series data from the ACCESS program. These datasets are undergoing final review by project partners before being made live in the MBON Data Portal. Axiom worked with data providers to iterate on the interactive visualization of the COASST Beached Bird Monitoring Data, 2005-2020. The data was transformed to Darwin Core and a prototype data layer was revised to include visualization and filter abilities for observation effort. Last, a visualization of over 35 year 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.
- **Task 5. Improve documentation.**
  Status: On-track
  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/**.**

- **Task 6. Engage with newly funded MBON projects.**
  Status: On-track
  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.
- **Task 7. Meeting Participation and Travel.**
  Status: On-track
  Axiom participated in semi-regular program phone meetings to represent data management for biological data and data products via the MBON Data Portal, the IOOS DMAC virtual meeting, and the xMBON virtual meeting in February 2021.

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

- **Task 1: Provide space in the Research Workspace to store all range series files for all HFR operators within the IOOS HFRNet (100%)**
  Status: On-track
  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 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.
- **Task 2: With input from the IOOS Program Office, scientists, and HFR operators, evaluate and develop new data tool(s) for improved decision-making**.
  Status: On-track
  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/
- **Task 3: Improve documentation on IOOS HFR website.**
  Status: On-track
  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.
- **Task 4: Project communications.**
  In March 2021, Axiom met with the new IOOS Surface Currents Program Manager to review progress and recalibrate the project for FY21, given the limited success in receiving archive-ready datasets. The recommendation was made to push real-time data feeds to the Axiom infrastructure, for inventory and data access, in addition to storage data onsite and curating redundant data copies to the cloud for long-term storage.

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

- **FY 2020 - Q4**
  - **Task 1: Determine the optimal cloud provider solution for the serverless data need.**
    Status: Completed
    Axiom worked with NOAA PMEL to scope potential cloud-based, serverless capabilities for data hosting. Over several meetings the advantages and trade-offs of two core

capabilities (AWS and Azure) were discussed and the optimal cloud provider solution was identified.

- **Task 2. Configure listeners and apply the modified PMEL RUDICS implementation to accept payloads from the Iridium satellite provider.**
  Status: Completed
  This task involves modifying ERDDAP to consume data from cloud native storage. The code modification was performed by PMEL, with technical support from Axiom.
- **Task 3. Modify PMEL RUDICS software for Cloud platform hosting, and integration into a serverless framework.**
  Status: Completed
  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.

- **FY 2021 - Q1**
  - **Task 1: Modify software to write parsed data payload into ERDDAP.** [PMEL/Axiom]
    Status: On-track
    Backend development work was completed to integrate quality control software with the cloud platform notification service.
  - **Task 2. Integrate quality control software with the cloud platform notification service.** [Axiom]
    Status: On-track
    During this performance period, Axiom completed a climatology interface extension within the IOOS QARTOD library (See: https://github.com/ioos/ioos_qc/tree/add-config-creator). The `QcConfigCreator` instance generates a config for `QcConfig` informed by reference datasets, such as climatologies, defined via configuration. The CreatorConfig performs checks. Also included in the packages is a `get_assets.py` script, which has been provided to download and prepare climatology datasets from NARR and Ocean Atlas.
  - **Task 3. Develop code to push quality controlled data, with QC flag information, into ERDDAP.**[Axiom]
    Status: On-track
    Backend work has been completed to develop code to push quality controlled data, with QC flag information, into ERDDAP.
  - The following tasks are delayed and were not completed during this performance period due to related tasks by project partners at NOAA PMEL not yet being delivered. These tasks will be ongoing through FY21:
    - Task 4. Configure Docker containerization of all system components. [Axiom]
    - Task 5. Operational dissemination with the Open-GTS framework. [PMEL/Axiom]
    - Task 6. Acceptance testing (PMEL/Axiom]

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

- **Subaward to University of Alaska International Arctic Research Center to update Historical Sea Ice Atlas twice a year.**
  - Update database with data for January 1 – December 31, 2020; Original completion date: May 2021.
    Status: Update with data through June 30, 2020 is complete; still awaiting release of data for July-December, 2021 from National Snow and Ice Data Center (anticipated summer 2021). Will process immediately upon release by NSIDC

    - Update visualization tool with new software, including full-color concentration scale and expansion to pan-Arctic domain; Original completion date: Early 2021
      Status: Complete.
    - Monitor usage of database; Original completion date: May 2021.
      Status: 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: Complete.
- **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. This will likely include the operational NCEP Climate Forecast System Version 2 (CFSv2) along with the experimental sea ice model and the Alaska Sea Ice Program (ASIP) analysis.
      Status: Complete
    - In collaboration with NWS Alaska, determine the specific forecast points of interest to NWS stakeholders where guidance is needed. (This could be gridded if approach supports this).
      Status: Complete.
    - Develop the statistical relationships over a specified training period to develop the probabilistic sea ice concentration guidance.
      Status: On Track. Axiom staff have created a predictive model using one forecast point and forecast model outputs. Next step is to create predictive model for remaining 300+ forecast points
    - 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.
      Status: On Track. Preliminary predictive model looks solid, however additional research and the creation of models for the remaining stations is needed before the Axiom team can make a determination of guidance skill.
    - 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.
      Status: Not 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.
      Status: On Track. Axiom staff are in the process of creating public repositories in Github for public access and sharing with NWS staff for future use.
- **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. Start: FY20Q3; End: FY22Q2.
- Automated pre-processing (VIMS and NOAA): Implement required scripts and tools for automatically constructing forcing and boundary conditions required by the coastal ocean model. This includes implementing tools to automatically checkout the latest updated Digital Elevation Model (DEM) from OCS' National Bathymetry Source program. Start: FY20Q3;End: FY21Q1.
- Data-driven mesh generation (NOAA and VIMS): Implement data-driven unstructured mesh generation framework based on DEM and forcing. Model implementation (VIMS and NOAA): Implement SCHISM 3D coastal ocean model, seamlessly coupled to wave and inland hydrology, as the coastal ocean model engine. This model provides flexibility and stability that allows us to locally increase unstructured mesh resolution to less than 20m mesh sizes. Start: FY20Q3; End: FY21Q2.
- Model deployment (VIMS, NOAA and Axiom): Implement capability to seamlessly run modeling system on conventional HPC and cloud environment; Start: FY21Q1; End: FY21Q4. 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. ParallelWorks is currently being explored for use for model simulations and potentially post-processing tasks that allows for orchestration on multiple cloud environments, high-level workflow definitions, and access to multiple storage providers.
- Post processing and dissemination (NOAA, VIMS and Axiom): Implement a cloud based environment for post-processing and dissemination of modeling system products; Start:FY21Q1; End: FY22Q1. ParallelWorks exploration is relevant to this task for providing a computational environment. Members of the team are currently developing scripts and applications specific to this use case utilizing libraries supported by the Pangeo community.
- 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. Start: FY21Q3; End: FY22Q2.

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

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

- **Subaward to University of Notre Dame**.
  - Develop improved strategies for meshing overland regions. Implement and test both Delaunay as well as Force Balance algorithms in order to keep shoreline nodes fixed in place or nearly in place on the actual shoreline; Original completion date March 2020.
    Status: Complete.
  - Develop strategies to optimize upriver river meshing so that the meshes can be readily couple to the National Water Model; Original completion date May 2020.
    Status: Complete.
  - Develop 1D mesh elements to be implemented in the OceanMesh2D code; Original completion date: September 2020.
    Status: Complete.
  - Develop element based internal barrier feature; Original completion date December 2020.
    Status: Complete.
  - Targeted mesh refinements of the 120m mesh; Original completion date February 2021.
    Status: Complete.
  - Targeted mesh refinements of the 30m mesh; Original completion date March 20201.
    Status: On track. I n progress with 85% completed and targeted completion August 31, 2021.
  - Implement targeted bathymetric improvements into the 120m mesh; Original completion date April 2021.
    Status: Complete.
  - Implement targeted bathymetric improvements into the 30m mesh; Original completion date May 2021.
    Status: Complete.
  - Validating 120m mesh with hurricanes; Original completion date June 2021.
    Status: On Track. In progress with 70% completed and targeted completion July 31, 2021.
  - Validating 30m mesh with hurricanes; Original completion date: July 2021.
    Status: On track. In progress with 30% completed and targeted completion August 31, 2021.
  - Activating river flows for 120m mesh simulations; Original completion date: August 2021.
    Status: Not started, projected completion August 31, 2021.
  - Activating river flows for 30m mesh simulations; Original completion date: September 2021.
    Status: Not started, projected completion September 30, 2021.

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: Some delays due to covid-19 travel restrictions, but will now continue through

extension year. Extended.
    - 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: One additional report willl be produced during extension year. Extended.
    - 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: Additional webinars will be hosted in summer/fall. Extended.
- **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: Complete. Bering Science report was released and distributed to all box holders in 39 western Alaska coastal communities in spring 2020. The report was also distributed via listserv, social media and to Alaska media. Bering Science fall 2020 update was completed and distributed online and through virtual platforms. The Spring 2021 update, which includes information on Winter 2021, has been completed and sent to all boxholders.
    - Set up community review panel to ensure that content is being co-produced and that we meet the needs of Indigenous communities.
      Status: Delayed due to COVID-19/Ongoing; Expected completion date of Summer 2021.
    - Rick Thoman to conduct outreach at Dillingham Science Conference and various coastal communities; Original completion date May 2020.
      Status: Delayed. The 2020 Western Alaska Interdisciplinary Science Conference was postponed due to COVID-19 pandemic. Conference was held virtually in 2021, and Rick Thoman gave invited presentation on project, but travel to communities (including Dillingham) has been precluded by COVID-19.
- **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: Complete.
    - 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: Complete.
    - Develop data and information products; Original completion date May 2021.
      Status: Complete.

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 transferred to a senior advisor position on January 1, 2021, at which time Sheyna Wisdom became the new Executive Director.

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	SBE- 37 microcat temperature and conductivity logger	$8,258
1	Eco-triplett	$14,000
1	Pacific Gyre Clobeacon	$10,000
1	EdgeTech PORT dual acoustic release	$13,000
1	LISST 200X	$37,725
1	KIT, LI Battery G2 4S 20Kg	$16,800