

OA Cruise Science Priority Guidance: Activities for Ocean Acidification Survey Cruises FY26-29

As a continuation of the Global Ocean Acidification Observing Network: Requirements and Governance Plan, the following list of core activities is designed for the NOAA Ocean Acidification Program survey cruises of the East Coast (ECO), West Coast (WCO), and Gulf Region (GOMECC). The intent of this effort is to ensure cruises provide a uniform set of measurements analyzed at the same quality following standard operating procedures (SOPs). Doing so will facilitate comparisons among regions and provide quality observations of key OA parameters to discern patterns and trends among subsequent cruises.

Activities are designated as level 1, level 2 and level 3, modeled after the [criteria provided for GO-SHIP cruises](#). Level 1 are required “core” activities for each cruise and should be prioritized under cases of resource limitation, including limitation in funding, ship size, ship time, and personnel. Level 2 are highly desirable activities and recommended when resources or leverage are available. Level 3 activities are ancillary and should be performed on a not-to-interfere and space-available basis. Level 3 includes novel approaches and technology development that could be implemented for future cruises. Activities within a given level are NOT ranked in order of importance.

The level designation of each parameter can change over time based on evolving scientific objectives and agreements between program managers and science teams. Once per OAP funding cycle, this document will be reviewed for designation changes. All core parameters will have a specification sheet that includes standard nomenclature and guidance for data submission to the OA database at NOAA's NCEI.

This document does not consider the water budget, time budget, personnel needs, or expense of the activities included at each level. Such considerations are vital to cruise planning and may affect what is possible on any individual cruise.

OA Cruise Objectives

- Acquire full water column characterization of critical measurements to document ocean acidification dynamics, mechanisms, and impacts in coastal waters.
- Fully constrain the carbonate system, temperature, salinity, and oxygen.
- Identify and track key biological metrics useful in ascribing marine resource changes in response to acidification.
- Provide data necessary to determine anthropogenic CO₂ signals.
- Ensure national alignment of data collection, analysis, and stewardship.
- Leverage partnerships to accomplish monitoring goals and encourage innovation in OA observing.

General Sampling Guidelines

- Across level 1 activities, constrain the offshore endmember and include deep reference stations across relevant boundary currents to capture slope-shelf interactions. Where feasible and appropriate, conduct measurements at near-shore stations either directly or through state or interagency coordination.
- Guidance is provided regarding ideal sampling depths and schemes. In practice, sampling schemes will depend on many factors, including weather and sea conditions, local bathymetry, and trust in altimeters and other packages on rosettes.
- When possible, on-board analysis of samples is preferred, but sample preservation and storage for shore-side analysis is acceptable when it will not significantly impact the accuracy or precision of the measurements.
- The lead scientist's judgment at sea supersedes the idealized guidelines outlined in the tables.

Activities for profiling sensors and Niskin bottle samples on rosette

Level 1 (required within available resources)

Activity	Purpose	Notes on Method or Process
<p>Measure salinity, temperature, pressure, and oxygen.</p>	<p>Used to understand basic physical processes. Oxygen is closely coupled to carbon dynamics and could be an OA co-stressor in hypoxic waters. Many proxy estimates of carbonate ion concentration have been performed using algorithms based on this data. Temperature and salinity can inform satellite-based algorithms.</p>	<p>Use profiling sensors on a rosette. Dual O₂, temperature, and conductivity sensors are recommended.</p> <p>Collect 1m depth average data from surface to <10m from bottom.</p> <p>CTD and O₂ sensors should be calibrated before and after the cruise by the manufacturer. However, the primary calibration for the O₂ data should be based on comparisons between sensor measurements and co-located bottle samples collected from the rosette and measured using the Winkler titration approach. Reference: Uchida, Johnson, and McTaggart, 2010.</p>
<p>Measure 3 carbonate system parameters.</p>	<p>Constrain the marine carbon system. Unidentified and organic alkalinity contributions from organic and unidentified sources, along with an incomplete understanding of the carbonate system, challenge our ability to use two measurements to fully constrain the carbonate system in the coastal environment. Three or more measurements allow estimation of unidentified contributions to alkalinity and provide direct measurements of the carbonate parameters that most directly affect biology.</p>	<p>Niskin bottle samples.</p> <p>DIC must be included. The other inorganic carbon variable(s) should be selected according to the following preferred order: TAlk, pH (total scale) and/or pCO₂. Reference: Guide to Best Practices for Ocean CO₂ Measurements (Dickson, Sabine, and Christian, eds.).</p> <p>Sample resolution guidelines: For deep water stations (>1000 m), sampling depth intervals should follow GO-SHIP standards to facilitate cross-cruise interpretation. Strategically sample shallower stations to capture prominent dynamics based on temperature, salinity, density, oxygen, and fluorescence. At a minimum, collect discrete samples at the surface, seawater intake depth (if different from surface), top and bottom of the thermocline, fluorescence maximum, oxygen minimum, oxygen maximum, and bottom depth.</p>
<p>Measure discrete oxygen.</p>	<p>Calibrate O₂ sensor data. Discrete O₂ samples have higher precision than profiling sensors and are therefore preferentially applied in mass balance</p>	<p>Niskin bottle samples analyzed using the Winkler titration method. Reference: Langdon, 2010.</p> <p>Sample resolution guidelines:</p>

	formulations. Discrete O ₂ is also needed for anthropogenic CO ₂ calculations and respiration studies.	<p>For deep water stations (>1000 m), sampling depth intervals should follow GO-SHIP standards to facilitate cross-cruise interpretation. Shallower stations should be sampled strategically to capture the prominent dynamics based on oxygen profiles. At a minimum and as niskin rosette size allows, collect discrete oxygen samples at the surface, the smallest oxygen sensor reading, the greatest oxygen sensor reading, any strong dynamic perturbation, and in bottom water. A duplicate sample at one depth is also recommended. In general, sampling should not exceed 10 bottles per station unless deemed necessary by the chief scientist.</p> <p>Conduct post-cruise secondary QC for profiling oxygen sensor. Reference: Uchida, Johnson, and McTaggart, 2010.</p>
Measure macronutrients (nitrate, silicate and phosphate).	Macronutrients have known effects on the dissociation constants of the carbonate system and inform understanding of biological processes through mass balance calculations.	Niskin bottle samples. Measure at the highest feasible depth resolution. Reference: Becker et al., 2019.
Conduct bottle salt analysis.	Validate thermosalinograph (TSG), CTD readings, and satellite salinity products.	Niskin bottle samples. Reference: Kawano, 2010.
Measure Chlorophyll fluorescence.	Informs understanding of the biological influence on carbon cycling. Can inform satellite-based algorithms.	Profiling fluorometer on the CTD rosette.
Measure chlorophyll- <i>a</i> .	Calibration and validation of satellite optical measures. Can help normalize biological productivity estimates to inform process understanding (when coupled with O ₂ and carbon data).	<p>Niskin bottle samples; filtered, extracted and analyzed on a calibrated instrument (fluorometer, spectrophotometer, HPLC, etc.)</p> <p>Sampling depths should be pre-determined and include at least the surface and the fluorescence maximum.</p> <p>May need 3-4 liters of water in oligotrophic waters at each site.</p>
Measure regionally relevant species to make	Determine impacts of OA exposure to organisms of	Methods will depend on the chosen regionally relevant species. Ideally, one species could act as

<p>advancements in determining “indicator species”.</p>	<p>interest or exposure indicators. Determine ecological trends with increasing acidification.</p> <p>An exposure indicator is predictably impacted by changes in pH or Ω. An ecological indicator is a species of ecological importance with sensitivity to OA.</p>	<p>both an exposure and ecological indicator. If not, choose two indicators and develop methods/understanding accordingly. Indicators should have demonstrated sensitivity to carbonate chemistry and/or social or ecological significance.</p> <p>Other considerations include the preservation potential of the biological indicator for use in historical reconstructions to extend the time horizon of observations.</p> <p>If applicable, use methods outlined in levels 2 and 3 below for the selected species.</p>
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Level 2 (Desirable with additional resources or leverage)

Activity	Purpose	Notes on Method or Process
<p>Measure 4th inorganic carbon system parameter.</p>	<p>Reduce error and uncertainty in the carbonate system.</p>	<p>Niskin bottle samples. Measure the 4th inorganic carbon parameter (pCO₂, pH, TA, or DIC) not measured as a level 1 activity.</p> <p>Reference: Guide to Best Practices for Ocean CO₂ Measurements (Dickson, Sabine, and Christian, eds.).</p>
<p>Measure calcium concentration.</p>	<p>Improve calculations of Ω. Most calculations of Ω rely on assumptions of calcium behaving conservatively with salinity, which is less likely in systems dominated by riverine input or in regions of high calcification.</p>	<p>Niskin bottle samples. Complexometric titration or ion chromatography.</p> <p>Target measurements where salinity values are below 25.</p>
<p>Conduct profiling radiometry and inherent optical property measurements including absorption, attenuation and particle backscattering (λ).</p>	<p>Informs satellite ocean color products that can, in turn, be applied to OA algorithm development.</p>	<p>Use profiling radiometry and optical sensors.</p> <p>1-2x/day, preferably coincident with an ocean color satellite overpass.</p>
<p>Measure regionally relevant benthic environment.</p>	<p>Characterize the benthic environment of a regionally relevant (ecologically or</p>	<p>Use a benthic lander where feasible.</p>

	<p>economically) species. Determine acidification trends over time. Provides measurements of the benthos for biogeochemical models.</p>	
<p>Inform regional and earth system models for carbon dynamics; parameterize/validate satellite-based estimates of ocean productivity.</p> <p>This includes measuring: Net primary production (NPP), net community respiration (NCR), net community production (NCP), particulate inorganic carbon (PIC), particulate organic carbon (POC), CaCO₃ mass, microbial production, and/or pigments.</p>	<p>NPP, NCR, NCP, and microbial production can be primary drivers of short-term carbonate dynamics.</p> <p>PIC, POC, and CaCO₃ mass are important aspects of the biological pump, which is a potential feedback mechanism to OA.</p> <p>In-situ pigments are critical to validating satellite-based estimates of net primary productivity and related Level 3 products.</p>	<p>Niskin bottle samples. NPP: Conduct ¹³C, ¹⁵N, ¹⁴C incubations NCR: Dark bottle incubations or ETS techniques based on bottle sampling throughout the water column. NCP: In situ (e.g., light) bottle incubations; profiling O₂:Ar techniques. PIC and POC: Filter samples on ship. Measure via high-temperature combustion and/or acid treatment. CaCO₃ mass: Filter samples on ship. Burn the organic matter. The remaining sample gets analyzed on CHN, and inorganic/organic carbon are determined using published data. CaCO₃ is calculated by multiplying by 8.33. Microbial production: Ship-board incubation. Pigments: Filter water samples for shore-side HPLC analysis.</p>
<p>Measure Chlorophyll absorption (λ), CDOM absorption (λ), filter pad absorption (λ).</p>	<p>Informs satellite-based algorithms for determining carbon fixation.</p>	<p>Niskin bottle samples. Spectrophotometry.</p>
<p>Measure zooplankton total biomass and abundance.</p>	<p>Establish carbon mass balance and aid in understanding of the biological carbon pump.</p> <p>Establish a baseline for future comparisons.</p> <p>Correlate OA to zooplankton biomass and abundance.</p>	<p>Collect samples via oblique tow to 200 m (or near bottom depth) with 335 μm nets (mesozooplankton) or ~150 μm nets (microzooplankton). Note: 500 μm mesh size is common on the west coast (CalCOFI).</p> <p>Measure biovolumes/biomass from the net before further processing of samples for community composition, total carbon, or total nitrogen.</p>
<p>Characterize zooplankton community composition and structure.</p>	<p>Correlate OA to zooplankton community composition and structure. Establish a baseline for future comparisons.</p>	<p>Collect samples via oblique tow to 200 m (or near bottom depth) with 335 μm nets (mesozooplankton) or ~150 μm nets (microzooplankton). Note: 500 μm mesh size is common on the west coast (CalCOFI).</p>

		Fix in formalin for community composition evaluation based on morphology. Fix in ethanol for molecular analysis to characterize community structure.
Characterize ichthyoplankton community composition and structure.	<p>Establish carbon mass balance and aid in understanding of the biological carbon pump and carbon cycling.</p> <p>Identify areas where economically relevant fish or invertebrate species with pelagic reproductive strategies spawn.</p> <p>Establish a baseline for future comparisons.</p>	<p>Collect samples via oblique tow to 200 m (or near bottom depth) with ~500 μm nets.</p> <p>Fix samples in formalin for community composition evaluation based on morphology. Fix samples in ethanol for molecular analysis to characterize community structure. Fix samples in ammonium buffered ethanol to measure calcification. Fix samples in tris-buffered ethanol for eDNA approaches.</p>
Measure larval fish standardized abundance.	<p>Identify areas where economically relevant fish or invertebrate species with pelagic reproductive strategies spawn.</p> <p>Establish a baseline for future comparisons.</p>	Standard methods: Flowmeters, calculate volume filtered, calculate larvae per volume filtered.
Measure pteropod abundance.	<p>Potential indicator species for particular regions and OA conditions. Can be evaluated against cruise-wide OA metrics and gradients.</p>	Collect zooplankton samples via oblique tow, Neuston, vertical tow, MOCNESS, etc. Can use classical abundance techniques.
Measure dissolution of pteropods, foraminifera, and/or regionally abundant calcifiers.	Acts as an indicator of biological change. Would provide validation of biological models.	Record % of each species with the most severe effect of dissolution using SEM or MicroCT. Sub-sample 10-15 individuals of each species measured from each site where they are collected.
Characterize HAB species community structure and abundance.	Relate HAB species community structure and abundance to carbonate chemistry conditions to be able to look at shifts of biodiversity and functional groups (including HABs) in response to OA.	Niskin bottle samples. Run FlowCAM/microscopy samples to determine HAB species presence on the cruise.
Measure HAB toxins.	Understanding HAB toxicity in relation to environmental conditions including carbonate chemistry.	Niskin bottle samples. Filter and preserve for post-cruise analysis of toxins. Conduct appropriate post-cruise analysis for assessing

		present toxins (e.g. FlowCAM, microscopy, targeted eDNA analysis, and/or targeted PCR). Can be guided by the community structure analysis.
Measure total bacterial abundance and community structure.	Relate bacterial abundance and community to carbonate chemistry conditions/biogeochemical processes.	Niskin bottle samples. Preserve them on ship for analysis. Use epifluorescence microscopy or appropriate and comparable DNA sequencing methods.
Determine community structure of pelagic calcifying & non-calcifying organisms - phytoplankton (e.g. coccolithophores) and zooplankton (e.g. pteropods and foraminifera).	The ratio of calcifiers vs non calcifiers could be used to determine community structure changes across an OA gradient.	Niskin bottle samples. eDNA analysis (using a combination of targeted assays (qPCR/dPCR) and metabarcoding analyses). May be paired with other analyses and imaging approaches (e.g. FlowCAM/net tows) to provide higher spatial and vertical resolution.
Conduct community rate measurements/growth and grazing across nano-, micro,-and mesoplankton.	Changes in community growth and grazing across 3 trophic levels in relation to carbon chemistry.	Collect water from niskin rosette, net tow for copepod grazers, analyses via microscopy, FlowCAM, targeted eDNA.
Measure $\delta^{13}\text{C}$ -DIC	Quantifies anthropogenic carbon accumulation; Provides a sensitive measure of mean seasonal NCP; Enables mechanistic interpretation of OA in places with low pH or Ω .	Collect water from niskin bottles. Acidify samples to release CO_2 and measure $\delta^{13}\text{C}$ -DIC using a whole-water CO_2 extraction device and a CRDS isotopic detector. Conduct CRM calibration regularly.

Level 3 (Not to interfere and space available basis)

Activity	Purpose	Notes on Method or Process
Measure transient tracers (SF6, CFCs).	Resolve water mass residence times; Anthropogenic carbon determination; useful for determining biological rates.	Reference: Bullister and Tanhua, 2010 .
Measure Ammonia.	Can be an important contributor to non-carbonate alkalinity.	Measure using a spectrophotometer, nutrient autoanalyzer, or an ammonia ion selective electrode (ISE). Measure in near-shore waters, including close to the benthic boundary layer.

Measure Dissolved Organic Matter.	Establish carbon mass balance.	Collect water samples, filter, preserve, and conduct post-cruise analysis (e.g. fluorescence spectroscopy).
Measure organic alkalinity.	Helps to resolve the carbonate system and account for differences between TA measured directly in seawater and TA calculated from other measured parameters.	Niskin bottle samples. Two-step titrations of samples purged of DIC. First titration from pH 4.5 to 6.0 performed using bromocresol purple (BCP), and a second titration, from pH 6.0 to about 8, using cresol red (CR) as the indicator. Follow the methods of Yang et al. 2015 (https://doi.org/10.1016/j.marchem.2015.09.008)
Measure CO_3^{2-} concentrations.	Acts as "5th" carbon parameter.	Niskin bottle samples. UV absorbance spectroscopy or titration methods.
Measurements on calcification of pteropods, foraminifera and/or regionally abundant calcifiers.	Useful for future projections of OA impacts on ecological indicators.	Collect organisms by oblique tow and measure calcification using incubation experiments with the alkalinity anomaly technique
Measure net community dissolution of calcite.	Assess shifts in net community dissolution in relation to OA	Measure dissolution of regionally abundant calcifiers. Collect community samples by oblique tow plus vertical hand net. Use the alkalinity anomaly method to measure dissolution.
Measure net community calcification.	Assess shifts in net community calcification in relation to OA.	Collect community samples by oblique tow plus vertical hand net. Measure calcification using the alkalinity anomaly method or ^{45}Ca incubation. (note: ^{45}Ca incubation requires filing an application to use radioactive material aboard a NOAA ship, which must be filed 3 months in advance of a domestic project or 8 months in advance of a foreign project.)
Conduct isotope analyses on pelagic calcifiers.	Understand isotope shell composition as a proxy for environmental changes, tracing energy flow and assimilation, or identifying organic matter sources.	Mass spectrometry.
Determine nutritional quality of zooplankton.	Assess potential food web impacts from OA. Correlate OA to carbon and nitrogen sources and trophic	Collect samples via oblique tow. Analyze C:N and free fatty acid composition. Freeze a portion for stable isotope analysis of size fractions of zooplankton, which also yields %C and %N data.

	transfer. Establish a baseline for future comparisons.	
Conduct nutritional analysis of phytoplankton.	Assess potential food web impacts from OA.	Collect samples via vertical hand net or Niskin bottle. Analyze C:N and free fatty acid composition. Note that hand nets will exclude the smallest phytoplankton (pico- and nano-, < 20 microns in size) that comprise the bulk of biomass in offshore stations, in which case whole seawater from Niskin bottles may be preferable, water budget allowing.
Measure HAB species.	Evaluate co-stressor and interactive effects of OA and HABs.	Collect samples via vertical hand net or appropriate eDNA sampling technique for eDNA analysis; or, use Imaging Flow Cytobot.
Measure predator-prey interactions.	Assess potential food web impacts from OA.	Combination of isotope work and targeted eDNA approaches to identify trophic positioning and unlock food web dynamics.
Conduct and characterize species-specific OMICS related response and OA attribution.	Characterization of species' stress response from changes in gene expression, energetic biomarkers, metabolite production, and protein composition. Provides attribution of OA and proposed cellular mechanisms.	Collect individuals from net tows and immediately preserve in -80C. Conduct appropriate transcriptomics, cellular biomarkers (metabolomics), lipidomics, and/or proteomics analysis. Ideally linked to paired multi-stressor experiments.

Activities for Underway Operations

These activities will require an uncontaminated scientific seawater supply line, sensor equipment attached to the ship, or visual observations. Seawater flow rate must be sufficient to provide for all Level 1 sensors and discrete sample collections before adding Level 2 and 3 measurements. The Chief Scientist is responsible for determining flow order based on flow rate to all sensors. Underway discrete samples should be logged with sufficient metadata to constrain the degree of co-location with other samples.

Level 1 (“Core” required within available resources)

Activity	Purpose	Notes on Method or Process
Record location, time, meteorological parameters	Basic foundational metadata and complimentary metadata that can be	Shipboard computing system.

(air T, RH, pressure, wind speed, direction).	applied to gas flux determinations.	
Measure temperature and salinity.	Needed to solve the carbonate system and calibrate/validate satellite surface salinity estimates.	Thermosalinograph.
Measure pCO ₂ .	Informs surface CO ₂ flux estimates with high-fidelity surface coverage.	Underway system such as a CO ₂ analytical system with a CO ₂ /H ₂ O Trace Gas Analyzer.
Measure a second carbon parameter (in order of preference: TA, DIC, pH)	Allows for surface layer determination of carbonate mineral saturation state.	Underway systems.
Measure all level 1 parameters.	Provides for cross-comparison between surface underway instrumentation and high precision analytical measures.	Discrete samples from underway seawater line every 1/4° while underway between CTD survey lines when no CTD rosette casts are conducted.

Level 2 (Desirable with additional resources or leverage)

Activity	Purpose	Notes on Method or Process
Record U and v velocity at designated depth bins (~5m).	Helpful for capturing advective carbon flux.	Shipboard ADCP. Pre-cruise calibration for water column scatterers is desired.
Record remaining carbon parameters not measured in level 1 (above; TA, DIC, and/or pH).	Providing a minimum of triple constraint to the carbonate system will allow for determining organic alkalinity contribution in the surface.	Underway systems.
Measure oxygen.	Inform apparent oxygen utilization (AOU) estimates in the surface mixed layer.	Underway system such as an in-line optode.
Measure nitrate.	Nitrate serves as a valuable additional term in multivariate empirical estimates of carbonate dynamics in addition to temperature, salinity, and oxygen.	Discrete sampling from uncontaminated seawater line. Reference: Becker et al., 2019 .
Measure red light attenuation (beam-c).	Red light (670nm wavelength) correlates to POC.	Underway system such as an in-line transmissometer.
Estimate net community production.	Can be used to isolate the net biological forcing of carbonate system dynamics in the surface.	O ₂ /Ar mass spec and subsequent physical oceanographic analyses.

Measure salinity.	Calibrate/validate conductivity sensor for salinity determination.	Conductivity sensor.
Measure Inherent optical water properties (attenuation, absorption, scattering).	Calibrate/validate satellite-based estimates of primary productivity and carbon export at the surface.	Absorption/attenuation instrument (e.g. Wetlabs ac9).
Measure phytoplankton community assemblage.	Understand phytoplankton community responses to OA.	Optical plankton recorder; e.g., FlowCAM or FlowCytoBot.

Level 3 (Not to interfere and space available basis)

Activity	Purpose	Notes on Method or Process
Sample chlorophyll-a and HPLC pigments.	Calibration/validation of satellite optical measures. Can help inform biological productivity estimates that can be coupled with O ₂ and carbon to inform process understanding.	Discrete samples from the underway line. Chl-a: extract/filter; HPLC pigments: shoreside analysis.
Sample dissolved organic carbon, particulate organic carbon, particulate inorganic carbon, and calcium carbonate.	Understanding carbon cycling and the biological carbon pump. Must be done in conjunction with other subsurface monitoring efforts (e.g. uncrewed systems, fixed observing stations, etc.)	Discrete samples from the underway line. This needs to be very targeted depending on the depth of the remineralization.

Activities related to General Cruise Operations

Level 1 (“Core” required and within available resources)

Activity	Purpose	Notes on Method or Process
Report on cruise activities to OAP for outreach/communication to the public.	Outreach and communication.	Assist OAP staff in providing fodder for weekly web-based social media, news stories, and/or website updates.
Report on weekly cruise activities to OAP.	Outreach and communication.	Weekly cruise reports- brief email summaries of cruise activities and progress, any hurdles that arise, etc.
Final cruise report.	Support cruise knowledge dissemination to researchers and other interested parties.	A detailed final cruise report to be posted publicly will be due within 12 months of the cruise execution. If deemed necessary by the cruise chief scientist, up to an additional 6 months at most may be provided in consultation with OAP staff.

Data Management.	Record and organize all data from the cruise.	Daily, weekly, whole-cruise tasks.
Weekly Cruise Science Meetings.	Align efforts and interests across the cruise science participants.	Cruise PI to conduct weekly cruise science briefs while at sea. Weekly meetings can be timed with safety drills.
Cross-validation of measurements.	Obtain multiple datasets that align with cruise efforts to cross validate.	Connect with other regional efforts to monitor OA related parameters to coordinate measurements (e.g. with NOAA-ON mooring stations, NPS, coastal reserves, other regionally relevant monitoring programs or stakeholders).
Leverage partnerships to deploy uncrewed systems from the cruise ship.	Obtain multiple datasets that align with cruise efforts.	Coordinate with PIs to deploy uncrewed systems such as gliders, drifters, BGC argo, and other relevant emerging technology during the OA cruise.
Cross Cruise Coordination Engagement.	To ensure coordination across cruises as appropriate.	Engage in conversations across cruises.

Level 2 (Desirable with additional resources or leverage)

Activity	Purpose	Notes on Method or Process
Outreach coordination across groups.	Outreach and communication.	If berth space allows, a graduate student(s) or Hollings scholar(s) should coordinate outreach efforts and contribute to the science of the cruise. Coordination with SeaGrant, aquariums, sanctuaries, national parks, and other marine science partners for outreach is encouraged.
Bring aboard an educator via NOAA's teacher at sea program or from a culturally or regionally relevant education group.	Outreach and communication.	https://teacheratsea.noaa.gov/
Coordinate with regional observing groups.	Ensure cross-effort coordination and create sampling efficiencies where possible.	Coordinate with IOOS Regional Associations, NERRS, NEPs, federal agencies, tribal groups, and/or academic partners.

Level 3 (Not to interfere and space available basis)

Activity	Purpose	Notes on Method or Process
Other media outreach.	Outreach and communication.	Miscellaneous media outlets.