OA Cruise Science Priority Guidance:
Activities for Ocean Acidification Survey Cruises FY24-26

As a continuation of the Global Ocean Acidification Observing Network: Requirements and Governance Plan, the following list of core activities is proposed for the NOAA Ocean Acidification (OA) Program survey cruises of the East Coast (ECOA), West Coast (WCOA), Gulf of Mexico (GOMECC) and an Alaska cruise. The intent of this effort is to have 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 and are provided using similar criteria as for GO-SHIP cruises. Thus, level 1 are required "core" activities for each cruise and should be prioritized under cases of resource limitation (e.g. funding, ship size, ship time, and personnel). Level 2 are highly advantageous/desirable activities and recommended when resources or leverage are available. Level 3 activities should be on a not-to-interfere and space-available basis. Novel approaches and new technology that could be implemented for future cruises are part of level 3. Activities within a given level are NOT ranked in order of importance. Level 2 and 3 activities will be solicited via NOFO and conducted at the discretion of the NOAA OA Program in consultation with the cruise's chief scientist(s). Decisions will be based on questions of interest for the region, ship time, funding, logistics, leveraged partnerships, and the interest and availability of collaborators.

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.

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 specific attribution of marine resource changes in response to acidification.
- Provide data necessary to determine anthropogenic CO_2 signal
- Ensure national alignment of data collection, analysis, and stewardship
- Leverage partnerships to accomplish monitoring goals and encourage innovation in OA observing

Activities for profiling sensors and Niskin bottle samples on rosette

Level 1 (required within available resources)

Activity	**Notes on Method or Process**	**Purpose**
Measure salinity, temperature, pressure, and oxygen	Use profiling sensors on rosette. Dual O_2, temperature, and conductivity sensors are recommended. Collect 1m depth average data from surface to <10m from bottom. Actual bottom depths will depend on many factors including weather and sea conditions, local bathymetry, and trust in the altimeter and other instrument packages on the rosette. The lead scientists' judgment at sea will supersede the <10m ideal. CTD and O_2 sensors should be calibrated before and after the cruise by the manufacturer. However, the primary calibration for the O_2 data should be based on comparisons between sensor measurements and colocated bottle samples collected from the rosette and measured using the Winkler titration approach. See the following for more details: https://www.go-ship.org/Manual/Uchida_CTDO2proc.pdf	Understanding basic physical processes. Oxygen is closely coupled to carbon dynamics via Redfield (or similar) 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.
Measure 3 carbonic acid system parameters. DIC must be included	Niskin bottle samples.	Constrain the marine carbon system. Unidentified and organic

	The other inorganic carbon variable(s) should be selected according to the following preferred order: TAlk, pCO_2 and/or pH (total scale) 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.	alkalinity contributions and 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 us to estimate unidentified contributions to alkalinity and help ensure we have direct measurements of the carbonate parameters that most directly affect biology.
Measure discrete oxygen	Niskin bottle samples. Use Winkler titration method. 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 the prominent dynamics based on oxygen profiles. At a minimum, collect discrete oxygen samples at the surface, the smallest oxygen sensor reading, the greatest oxygen sensor reading, any strong dynamic perturbation, at depth, and at a duplicate depth. Sampling beyond those required depths will depend on personnel and resources. In general, sampling should not exceed 10 bottles per station barring extraordinary exceptions as deemed necessary by the chief scientist. Conduct post-cruise secondary QC for profiling oxygen sensor using methods of Owens and Millard (1985). See	Primarily: calibrate O_2 sensor data. Discrete O_2 samples have higher precision than profiling sensors and are therefore preferentially applied in mass balance formulations. Discrete O_2 is also needed for anthropogenic CO_2 calculations and respiration studies.

	https://www.go-ship.org/Manual/Uchida_CTDO2proc.pdf for reference.	
Measure macronutrients (nitrate, silicate and phosphate)	Niskin bottle samples. Measure at the highest feasible depth resolution. On board analyses are preferred; frozen samples and shoreside analyses are acceptable	Have known effects on the dissociation constants of the carbonate system. Inform understanding of biological processes through mass balance calculations.
Conduct bottle salt analysis	Niskin bottle samples. On-board analysis is desired. Storage and shore-side analysis are acceptable when necessary.	Check thermosalinograph (TSG) and CTD readings. Validate satellite salinity products.
Measure Chlorophyll fluorescence	Profiling fluorometer on the CTD rosette.	Informs understanding of the biological influence on carbon cycling. Can inform satellite-based algorithms.
Measure chlorophyll-*a*	Niskin bottle samples. Extract/filter; Conduct pre and post calibration. Sampling depths should be pre-determined and include at least surface and the fluorescence max. Future discussion may further align depth across cruises. May need 3-4 liters of water in oligotrophic waters at each site.	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).
Measure regionally relevant species to make advancements in determining “indicator species”	Methods will depend on the chosen regionally relevant species. This indicator should have demonstrated sensitivity to carbonate chemistry and/or social or ecological significance. Other considerations include the preservation potential of the biological indicator for use in historical reconstructions to extend the time horizon of observations. If applicable, use methods outlined in levels 2 and 3 below for the selected species.	Determine impacts of OA on exposure and/or ecological indicators. Determine ecological trends with increasing acidification. An exposure indicator is a biogeochemical proxy to changes to pH/omega. An ecological indicator is a species of ecological importance with sensitivity to OA. Ideally, one species could act as both an exposure and ecological indicator. If not, choose two indicators and develop

		methods/understanding accordingly.

Across relevant 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, secure stations near-shore (within depth constraints and logistical limitations). Promote state and other agency coordination to secure synoptic sampling in neighboring shallow waters of significance.

Level 2 (Desirable with additional resources or leverage)

Activity	**Notes on Method or Process**	**Purpose**
Measure 4th inorganic carbon system parameter	Niskin bottle samples. Measure the 4th inorganic carbon parameter not measured as a level 1 activity.	Reduce error and uncertainty in the carbonate system.
Measure calcium concentration	Niskin bottle samples. Complexometric titration or ion chromatography. Measure where salinity values are below 25.	Most calculations of omega rely on assumptions of calcium behaving conservatively with salinity. We know this is likely not the case in systems dominated by riverine input or in regions of high calcification.
Conduct profiling radiometry and inherent optical property measurements including absorption, attenuation and particle backscattering (λ)	Use profiling radiometry and optical sensors. 1-2x/day, preferably coincident with an ocean color satellite overpass	Informs satellite ocean color products that can, in turn, be applied to OA algorithm development.
Measure regionally relevant benthic environment	Use a benthic lander where feasible. Where methods are not ironed out or a lander is not feasible, this may become a level 3 activity at any given site.	Characterize the benthic environment of a regionally relevant (ecologically or economically) species. Determine acidification trends over time. Provides measurements of the benthos for biogeochemical models.
Measure net primary production	Niskin bottle samples. Conduct ^{13}C, ^{15}N, ^{14}C incubations	Useful in informing regional and earth system modeling for carbonate dynamics and parameterizing/validating satellite-based estimates of net primary productivity and related L3 products. NPP can

		be a primary driver of short-term carbonate dynamics.
Measure net community respiration	Niskin bottle samples. Using dark bottle incubations, profile ETS techniques	Useful in informing regional and earth system modeling for carbonate dynamics and parameterizing/validating satellite-based estimates of net primary productivity and related L3 products. NCR can be a primary driver of short-term carbonate dynamics.
Measure net community production	Niskin bottle samples. Conduct in situ (e.g., light) bottle incubations, profile O2:Ar techniques	Useful in informing regional and earth system modeling for carbonate dynamics and parameterizing validating satellite-based estimates of net primary productivity and related L3 products. NCP can be a primary driver of short-term carbonate dynamics.
Measure microbial production	Niskin bottle samples. Ship-board incubation	Useful in informing regional and earth system modeling for carbonate dynamics.
Measure pigments using HPLC methods	Niskin bottle samples. Filter water samples for shore-side HPLC analysis.	Parameterizing/validating satellite-based estimates of net primary productivity and related L3 products.
Measure Particulate Inorganic Carbon and Particulate Organic Carbon	Niskin bottle samples. Filtered samples on ship. Water needs will vary depending on station depth.	Useful in informing regional and earth system modeling for carbonate dynamics and parameterizing/validating satellite-based estimates of net primary productivity and related L3 products. Are important aspects of the biological carbon pump, which is a potential feedback/amplifier to OA over decadal timescales.
Measure $CaCO_3$ mass	Niskin bottle samples. Filter samples on ship. Burn the organic matter. Whatever remains gets analyzed on CHN, form there Cinor vs Corg can be determined using published data, and CaCO3 is calculated by multiplying by 8.33	Useful in informing regional and earth system modeling for carbonate system dynamics and parameterizing/validating satellite-based estimates of net primary productivity and

		related L3 products.
Measure Chlorophyll absorption (λ), CDOM absorption (λ), filter pad absorption (λ)	Niskin bottle samples. Spectrophotometry.	Informs satellite-based algorithms for determining carbon fixation.
Measure zooplankton total biomass and abundance	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). Measure biovolumes/biomass from the net before further processing of samples for community composition, total carbon, or total nitrogen.	Carbon mass balance; biological carbon pump; cycling Establish a baseline for future comparisons. Correlate OA to zooplankton biomass and abundance.
Characterize zooplankton community composition and structure	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 sizes is common on the west coast (CalCOFI). Fix in formalin for community composition evaluation based on morphology. Fix in ethanol for molecular analysis to characterize community structure.	Correlate OA to zooplankton community composition and structure. Establish a baseline for future comparisons.
Characterize ichthyoplankton community composition and structure	Collect samples via oblique tow to 200 m (or near bottom depth) with ~500 µm nets. Preservation method is important. Fix in formalin for community composition evaluation based on morphology. Fix in ethanol for molecular analysis to characterize community structure. Fix in ammonium buffered ethanol to measure calcification. Fix in tris-buffered ethanol for eDNA approaches.	Carbon mass balance; biological carbon pump; carbon cycling. Identify areas where economically relevant fish or invertebrate species with pelagic reproductive strategies spawn. Establish a baseline for future comparisons.
Measure larval fish standardized abundance	Standard methods: Flowmeters, calculate volume filtered, calculate larvae per volume filtered.	Identify areas where economically relevant fish or invertebrate species with pelagic reproductive strategies

		spawn. Establish a baseline for future comparisons.
Measure pteropod abundance	Collect zooplankton samples via oblique tow, Neuston, vertical tow, MOCNESS, etc. Can use classical abundance techniques.	Potential indicator species for particular regions and OA conditions; some species are widespread, with similar importance. Can be evaluated against cruise-wide OA metrics and gradients.
Measure dissolution of pteropods, foraminifera, and/or regionally abundant calcifiers	Record % of each species with the most severe effect of dissolution using SEM or MicroCT. Sub-sample of 10-15 individuals of each species measured from each site where they are collected.	Acts as a strong indicator of biological change. Would provide validation of biological models.
Characterize HAB species community structure and abundance	Niskin bottle samples. Run FlowCAM/microscopy samples to determine HAB species presence on the cruise.	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
Measure HAB toxins	Niskin bottle samples. Filter and preserve for post-cruise analysis of toxins. Run FlowCAM/ microscopy samples to determine toxin presence on the cruise. Conduct appropriate post-cruise analysis for assessing present toxins (e.g. FlowCAM, microscopy, targeted eDNA analysis, and/or targeted PCR). Guided by the community structure analysis above.	Understanding HAB toxicity in relation to environmental conditions including carbonate chemistry.
Measure total bacterial abundance and community structure	Niskin bottle samples. Preserve them on ship for analysis. Use epifluorescence microscopy or appropriate and comparable DNA sequencing methods.	Relate bacterial abundance and community to carbonate chemistry conditions/biogeochemical processes.
Determine community structure of pelagic calcifying & non-calcifying organisms - phytoplankton (e.g coccolithophores) and zooplankton (e.g. pteropods and foraminifera)	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) in order to provide higher spatial and vertical resolution.	The ratio of calcifiers vs non calcifiers could be a very useful metric to determine community structure changes across an OA gradient.

Conduct community rate measurements/growth and grazing across nano-, micro,-and mesoplankton.	Collect water from CTD, net tow for copepod grazers, analyses via microscopy, FlowCAM, targeted eDNA	Changes in community growth and grazing across 3 trophic levels in relation to carbon chemistry.

Level 3 (Not to interfere and space available basis)

Activity	**Notes on Method or Process**	**Purpose**
Measure transient tracers (SF6, CFCs)	Probably challenging to perform regularly but might be doable on a periodic basis (e.g. once every 10 years)	Resolve water mass residence times; Anthropogenic carbon determination; useful for determining biological rates.
Measure Ammonia	Measuring using a spectrophotometer or an ammonia ion selective electrode (ISE). Measure in near-shore waters, including close to the benthic boundary layer	Can be an important contributor to non-carbonate alkalinity.
Measure Dissolved Organic Matter	Collect water samples, filter, preserve, and conduct post-cruise analysis	For carbon mass balance purposes.
Measure organic alkalinity	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)	Helps to resolve the carbonate system and account for differences between TA measured directly in seawater and TA calculated from other measured parameters.
Measure CO_3 concentrations	Niskin bottle samples. UV absorbance spectroscopy or titration methods.	Acts as “5th” carbon parameter
Measurements on calcification of pteropods, foraminifera and/or regionally abundant calcifiers	Collected by oblique tow and measured using incubation experiments with the alkalinity anomaly technique	This would be dependent on a lot of abiotic parameters, but this kind of measurement could be very useful for future projections.
Measure Net community dissolution	Measure dissolution of regionally abundant calcifiers. Community samples collected by oblique tow plus vertical hand net, dissolution measurements taken by alkalinity anomaly method	To assess shifts in net community dissolution in relation to OA

Measure Net community calcification	Community samples collected by oblique tow plus vertical hand net, calcification measurements taken by alkalinity anomaly method or 45Ca incubation (note: 45Ca 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.)	To assess shifts in net community calcification in relation to OA
Conduct Isotope analyses for: 1) isotope shell composition as a proxy for environmental changes (C, O isotope): 2) tracing energy flow and assimilation or organic matter sources	Stable isotopes analysis on major pelagic calcifying group	Used to 1) determine the exposure of calcifiers to various environmental conditions (pH, temp) and 2) identify food pathways within ecosystems.
Determine nutritional quality of zooplankton	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. Isotope data for organisms <1000 μm have been the focus.	To assess potential food web impacts from OA Correlate OA to carbon and nitrogen sources and trophic transfer. Establish a baseline for future comparisons.
Conduct nutritional analysis of phytoplankton	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.	To assess potential food web impacts from OA
Measure HAB species production	Collect samples via vertical hand net or appropriate eDNA sampling technique for eDNA analysis	Evaluating co-stressor and interactive effects of OA and HABs.
Measure predator-prey interactions	Combination of isotope work and targeted eDNA approaches to identify trophic positioning and unlock food web dynamics	To assess potential food web impacts from OA

Conduct and characterize species specific OMICS related response and OA attribution.	Collect individuals from net tows and immediately preserve in -80C. Conduct appropriate transcriptomics, cellular biomarkers (metabolomics), and/or proteomics analysis.	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. 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.
An SOP should be produced for underway measurements including:
1) Need to emphasize importance of flow order and flow rate to all sensors;
2) The importance of logging and coordinating time and location of sample collection to constrain degree of co-location of samples;
3) Specifically, seawater flow rate must be sufficient to provide for all Level 1 sensors and discrete sample collections before adding Level 2 and 3 measurements at the discretion of the Chief Scientist.

Level 1 ("Core" required and within available resources)

Activity	**Notes on Method or Process**	**Purpose**
Record location, time, meteorological parameters (air T, RH, pressure, wind speed, direction)	Shipboard computing system	Basic foundational metadata and complimentary metadata that can be applied to gas flux determinations.
Measure salinity	Thermosalinograph	Needed to solve the carbonate system and calibrate/validate satellite surface salinity estimates.
Measure pCO2	Underway system	Informs surface CO_2 flux estimates with high-fidelity surface coverage.
Measure a second carbon parameter (in order of preference: TA, DIC, pH)	Underway system	Allows for surface layer determination of carbonate mineral saturation state.
Measure all level 1 Niskin	Discrete samples from underway seawater	Provides for

bottle parameters	line every 1/4° while underway between CTD survey lines when no CTD rosette casts are conducted.	cross-comparison between surface underway instrumentation and high precision analytical measures.

Level 2 (Desirable with additional resources or leverage)

Activity	**Notes on Method or Process**	**Purpose**
Record U and v velocity at designated depth bins (~5m).	Shipboard ADCP. Pre-cruise calibration for water column scatterers is desired.	Helpful for capturing advective carbon flux.
Record remaining carbon parameters not measured in level 1 (above; TA, DIC, and/or pH)	Underway system	Providing a minimum of triple constraint to the carbonate system will allow for determining organic alkalinity contribution in the surface.
Measure oxygen	Underway system	Inform apparent oxygen utilization (AOU) estimates in the surface mixed layer.
Measure nitrate	Underway system	Nitrate serves as a valuable additional term in multivariate empirical estimates of carbonate dynamics in addition to temp>sal>O_2.
Measure red light attenuation (beam-c)	Underway system	Red light (670nm wavelength) correlates to POC.
Estimate net community production	O_2/Ar mass spec and subsequent physical oceanographic analyses.	Can be used to isolate the net biological forcing of carbonate system dynamics in the surface.
Measure salinity	Conductivity sensor	Calibrate/validate conductivity sensor for salinity determination.
Measure Inherent optical water properties (attenuation, absorption, scattering)	Absorption/attenuation instrument (e.g. Wetlabs ac9)	Calibrate/validate satellite-based estimates of primary productivity and carbon export at the surface.
Measure phytoplankton community assemblage	Optical plankton recorder; e.g., FlowCAM, FlowCytoBot if intake lines are suitable	Understand phytoplankton community responses to

		OA.

Level 3 (Not to interfere and space available basis)

Activity	**Notes on Method or Process**	**Purpose**
Sample chlorophyll-a and HPLC pigments	Discrete samples from the underway line. Chl-a: extract/filter; HPLC pigments: shoreside analysis.	Calibration/validation of satellite optical measures; can help inform biological productivity estimates that can be coupled w/ O2 and carbon to inform process understanding.
Sample dissolved organic carbon, particulate organic carbon, particulate inorganic carbon, and calcium carbonate	Discrete samples from the underway line. This needs to be very targeted depending on the depth of the remineralization.	Use for understanding carbon cycling and biological carbon pump. Must be done in conjunction with other subsurface monitoring efforts (e.g. uncrewed systems, NOA-ON stations, etc.)

Activities related to General Cruise Operations

Level 1 ("Core" required and within available resources)

Activity	**Notes on Method or Process**	**Purpose**
Report on cruise activities to OAP for outreach/ communication to the public	Assist OAP staff in providing fodder for weekly web-based social media, blog post, news story, and/or website updates*	Outreach and communication.
Report on weekly cruise activities to the funding program	Weekly cruise reports- brief email summaries of cruise activities and progress, any hurdles that arise, etc.	Outreach and communication.
Final cruise report	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.	In support of cruise knowledge dissemination to researchers and other interested parties.
Data Management	Daily, weekly, whole-cruise tasks	Record and organize all data from the cruise.
Weekly Cruise Science Meetings	Cruise PI to conduct weekly cruise science briefs while at sea, the first of which includes	Align efforts and interests across the

	sexual assault and sexual harassment (SASH) information about intolerance and reporting. Weekly meetings can be timed with safety drills.	cruise science participants.
Coordinate with other efforts to measure parameters	Connect with other regional efforts to monitor OA related parameters to coordinate measurements (e.g. with NOA-ON mooring stations, NPS, coastal reserves, other regionally relevant monitoring programs or stakeholders).	Obtain multiple datasets that align with cruise efforts to cross validate.
Leverage partnerships to deploy uncrewed systems from the cruise ship	Coordinate with PIs to deploy uncrewed systems such as gliders, drifters, BGC argo, and other relevant emerging technology during the OA cruise.	Obtain multiple datasets that align with cruise efforts.
Cross Cruise Coordination Engagement	Engage in conversations across cruises.	To ensure coordination across cruises as appropriate.

*Some training on NOAA communication requirements, and plain language training would be helpful. Note that it is difficult for federal employees to lead development of a blog due to NOAA communications rules and that cruise blogs can't be hosted on official NOAA websites.

Level 2 (Desirable with additional resources or leverage)

Activity	**Notes on Method or Process**	**Purpose**
Outreach coordination across groups	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.	Outreach and communication.
Bring aboard an educator via NOAA's teacher at sea program	https://teacheratsea.noaa.gov/	Outreach and communication.

Level 3 (Not to interfere and space available basis)

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