Cooperative Hypoxia Assessment and Monitoring Program ("CHAMP") Update;

An addendum to the 6th Annual NOAA/NGI Hypoxia Research Coordination Workshop proceedings paper, "Building a Cooperative Monitoring Program for Gulf of Mexico Hypoxia and Interrelated Issues"

This report should be cited as: Trevor Meckley, Becky Allee, Steve Ashby, Christopher Brown, Kevin Craig, Steven Dimarco, Brian Dzwonkowski, Steve Giordano, David Hilmer, Stephen Howden, Dubravko Justic, Barb Kirpatrick, Kirsten Larsen, Alan Lewitus, Nancy Rabalais, Angela Sallis, David Scheurer, Danny Wiegand. 2018. An addendum to Building a cooperative monitoring program for Gulf of Mexico hypoxia and interrelated issues. Proceedings Paper from the 7th Annual NOAA/NGI Hypoxia Research Coordination Workshop, 9-10 January 2018, at the Mississippi State University Science and Technology Center at NASA's Stennis Space Center in Mississippi, 30 pages.

See Workgroup Descriptions for Affiliations.

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Introduction

The *6th Annual NOAA/Northern Gulf Institute (NGI) Hypoxia Research Coordination Workshop* (12-13 September 2016, at Stennis Space Center, Mississippi), "Establishing a Cooperative Hypoxic Zone Monitoring Program" and the follow-up workshop proceedings paper led to the establishment of eight workgroups to establish the Cooperative Hypoxia Assessment and Monitoring Program (CHAMP). The workgroups encompass regional, topical, and management focuses that intersect with and would benefit from a multi-partner, sustainable Gulf of Mexico hypoxia monitoring program. The workgroups include: Fisheries Monitoring (1); the states of Louisiana (2), Mississippi/Alabama (3), and Texas (4); Autonomous Vehicles (5); Hypoxia Task Force (6); Ocean Acidification (7); and Gulf Restoration (8). The purpose of the *7th Annual NOAA/NGI Hypoxia Research Coordination Workshop* (7-9 January 2018 at Stennis Space Station, Mississippi), "Building the Cooperative Hypoxia Assessment and Monitoring Program (CHAMP)" was to assess progress of these monitoring workgroups toward building the CHAMP program, and further advance strategic planning to meet remaining CHAMP programmatic and financial goals and objectives (NGI CHAMP). Workshop objectives were to:

1. Revisit CHAMP requirements and determine the current state of the monitoring program based on progress since the original workshop.
2. Assess the remaining programmatic gaps and determine short- and long-term priorities in filling these based on identified management and stakeholder needs.
3. Identify potential partners and leveraging strategies for sustained support for current and future requirements.
4. Determine pathways for enhancing stakeholder awareness of the CHAMP program to better leverage and extend participation and support across multiple groups.

This report is one of the outputs from the 2018 workshop. It describes progress in building the CHAMP and serves as an addendum to the proceedings paper from the 6th Annual NOAA/NGI Hypoxia Research Coordination Workshop. Included are revisions to the proceeding paper's monitoring matrix (Tables 2 and 3 of the proceedings paper) and workgroup descriptions and development of a comprehensive data management plan, initially discussed at the *6th Annual Workshop* but refined at the *7th Annual Workshop.*

The CHAMP program strives to achieve five products instrumental to the Mississippi River/Gulf of Mexico Hypoxia Task Force (HTF) management needs. These include: (1) providing monitoring data for the annual hypoxic zone size to determine progress towards the HTF coastal goal; (2) determining the relationship between nutrient reduction and the dead zone size for revising nutrient management targets; (3) providing a holistic understanding of the physical, biological, and chemical components that drive hypoxia; (4) what impact other stressors such as diversions will have on hypoxia; and (5) how will the dead zone change given changing ocean

conditions and what are the impacts on marine resources. The eight workgroups continue to make progress toward these critical management needs. At the workshop, five notable contributions since the 2018 annual workshop were reported by the following workgroups and CHAMP members.

1. **Fisheries Workgroup –** Better depth readings were required with CTD casts on SEAMAP cruises (Workshop agenda attached, "FMW Workshop"). Altimeters were subsequently added to SEAMAP vessels (2 of 3), including the Oregon II and Pisces in 2018. An altimeter has been requested for the Gordon Gunter, with the expectation of deployment in 2019.

2. **Mississippi and Alabama Workgroup –** Scientists in this region have been working to document and understand the annual and persistent hypoxic zone east of the Mississippi Bight. The first of many papers is now available documenting the phenomena and its importance to understanding gulf wide hypoxia prevalence and impacts (i.e. Dzwonkowski et al. 2018). The lack of recognition that hypoxia is an issue east of the Mississippi has made gaining funding difficult. This group held an annual meeting on September 20th, 2018 to determine common research efforts and leveraging opportunities.

3. **Louisiana Workgroup –** A Gulf of Mexico Alliance Grant to support a critically needed monitoring transect off Barataria Pass has been attained. Three cruises were performed along a monitoring transect extending from Barataria Pass to the inner shelf in 2018. This transect is necessary to establish baseline conditions and monitor far-field effects of proposed diversions on hypoxia and the coastal zone.

4. **Autonomous Underwater Vehicles –** Over the past several years, members of the team have pursued efforts to understand the constraints with using glider technology to map the dead zone, which often occurs within several meters of the bottom. Gliders, which rely on buoyancy adjustments and currents for movement rather than a propeller, have been tested. Due to the very different buoyancy levels of the stratified and bottom layers, vehicles were unable to reliably reach the bottom and sample hypoxia. To overcome these constraints, NOAA members of the team have petitioned the NOAA small business innovation research (SBIR) program to support hypoxia related new autonomous vehicle monitoring technology development that could augment ship-based monitoring for hypoxia. Two designs will be tested, one with a propeller that may now be possible due to improved battery technology and one that is an unmanned surface vessel that will use a winch to drop a sensor to the bottom. Over the FY2019-2021 timeframe these devices must demonstrate, through a specific set of field tests, that they can augment hypoxia monitoring to achieve additional support for research development.

5. A data management advancement by CHAMP members, titled the *CTD Grabber*, has taken a ships of opportunity approach to ensuring that all data collected on NOAA ships is available and backed up as robustly as possible. CTD casts on the NOAA ships Gordon Gunter, Pisces, and Oregon III are both archived locally and transferred by the CTD grabber for archival and dissemination to related programs that utilize and distribute the data (i.e., Hypoxia Watch, Figure 1). See Figure 2 for the data transfer pathway**.**

Revised Monitoring Matrix

During Working Session 2 of the *7th Annual NOAA/NGI Workshop*, attendees revised the CHAMP monitoring matrix (Tables 2 and 3 from the *6th Annual NOAA/NGI Workshop* proceedings paper) by incorporating additional monitoring requirements determined by the monitoring workgroups, updating the remaining programmatic gaps, and identifying priorities in filling these based on management needs. The revised monitoring matrix is presented below.

Revised Table 2 of the 6th Annual Hypoxia Research Coordination Workshop <u>proceedings paper</u>. Monitoring system requirement options to meet data needs for Management Product 1 (annual mid-summer hypoxic zone areal extent). Codes: S = Ship Survey; D = Data Management.

Bin 1: Ship Shelf-wide Survey – Hypoxia Task Force Monitoring Workgroup
Management Product 1: Annual mid-summer hypoxic zone areal extent – metric for Hypoxia Task Force Coastal Goal.

Code	System Requirement	Collaborators	Estimated Annual Cost	Funding Status
Ship Survey	Mid-summer shelf-wide ship survey west of Mississippi Delta	LUMCON; LSU; NOAA; NGI	$200K using contract Potential offset from OMAO ship time Pelican costs ~11K/day	<u>Supported</u>: $200K by NOAA NCCOS for FY18 and FY19 <u>Needed</u>: $210K for FY20 and beyond (5% annual increase)
	Additional Shelf wide surveys –mid-summer survey often miss maximum zone size			<u>Needed for improved models –</u> not included in annual funding need total.
Data Management	Maintain a data portal to make data accessible & to facilitate exchange (data management)	GCOOS; NCEI	$35K for 3 months FTE (GCOOS)	<u>Supported</u> by NOAA IOOS to GCOOS through FY20
			$35K for 3 months FTE (NCEI)	<u>Supported</u>: NOAA NCEI ongoing
Communication	Dissemination of data and findings to research and management communities (communication)	LUMCON; LSU; GCOOS (determine specific costs for outreach such as press releases and graphics, etc)	$35K for 3 months FTE for GCOOS	<u>Supported</u> by NOAA IOOS to GCOOS through FY20
			$35K for 3 months FTE LSU/LUMCON	<u>Supported</u> by LSU/LUMCON in FY18 <u>Needed</u>: FY19 and beyond

Total Annual Cost (FY19 and beyond): ~340k
<u>Need FY18: $0, Need FY19: $0k, Need FY20:</u> $245k

Revised Table 3 of the 6th Annual Hypoxia Research Coordination Workshop proceedings paper. Monitoring system requirement options to meet data needs of Management Products 2-5. Codes for #: N = Nutrient Loading Estimates; S = Ship Surveys; O = Fixed Observing Systems; G = Gliders; D = Data Management.

Bin 2: Empirical Model Support – Hypoxia Task Force Monitoring Workgroup
Management Product 2: Guidance on nutrient reduction requirements to meet the Hypoxia Task Force Coastal Goal.

#	System Requirement	Collaborators	Estimated Annual Cost	Funding Status
Riverine Inputs N-3	Annual and Spring P and N loading estimates from Miss/Atchafalaya River Basin	USGS: Miss R at St. Francisville; Atch R at Melville); LSU: Miss R at Baton Rouge	$20K (USGS)	Supported: USGS ongoing
			$65K (LSU)	Supported: by LSU in FY19 or Needed: in FY20 and beyond
	Nutrient monitoring to support P and N load estimations (discrete sampling and real-time nitrate monitoring) from Miss/Atchafalaya River basin	USGS: Discrete sampling - Miss R at St. Francisville; Atch R at Melville; Real-time nitrate – Miss R at Baton Rouge; Atch R at Morgan City	$220K (USGS)	Supported: USGS ongoing
	Daily discharge monitoring	USACE: Discharge for Miss R at Tarbert Landing (01100), and Atch R at Simmesport (03045)	$80K (USACE)	Supported: USACE ongoing

Inputs from other river systems, mainly for FW input and stratification
Linkages with NWM and riverine input
Groundwater discharge important in some systems (east of delta, Mobile bay)

Total Annual Cost (FY19 and beyond): $385

- **Need FY18: $0, Need FY19: 65k, Need FY20: 65k**

DETERMINISTIC MODEL SUPPORT
Management Product 3: 3D time variable model characterization of Hypoxic Zone spatial and temporal dynamics
Management Product 4: Hypoxia impacts on living resources and habitats
Management Product 5: Scenario forecasts that include interactive ecosystem stressors

#	System Requirement	Collaborators	Estimated Annual Cost	Funding Status
Bin 3: Characterization of hypoxia east of Mississippi Delta (Mississippi Sound and Mobile Bay) – Mississippi/Alabama Monitoring Workgroup				
Ship Surveys	AL transect line	USA/Dauphin Island Sea LAB (DISL)	AL transect line (5-30K depending on frequency and measurement extent)	AL transect line: Needed
	USGS Small vessel in MS sound	State funded Various sources	Undisclosed	

	Mid-summer shelf-wide survey east of Miss Delta	USM; LUMCON; LSU; USA/DISL	$50K	Needed
	Lake Ponchartrain transect	Lake Pontchartrain Basin Foundation	10K per year for acquisition and Monitoring	Funded
Observing systems	Bottom measurements associated with EFH study	NFWF	No cost reported	Needed – 0 Research Project, short term.
	Real-time monitoring stations in the MS Sound (some D.O.)	USGS/MSDMR	East Ship Island Light Gulfport Light	Needed – 0 Funded
	Maintain observation system east of Miss Delta offshore of Dauphin Island on AL transect: site WE_CP – part of Alabama Real-times Coastal Observation System (ARCOS)	DISL/USA	~50K per year maintain	Supported: NOAA Restore program: ~320K from equipment upgrades including real-time telemetry and operational cost in 2018, 2019 and 2020. Supported: NOAA Gulf of Mexico Regional collaboration team: ~13K Supported: Data management of historical archive (>10 years of hydrographic data) ~20K Needed: Addition sensors and equipment ~100K

	Maintain observation system east of Miss Delta at end of USM transect: USM 3M01	GCOOS; USM	Year 1: $50K to outfit with DO sensor Year 2 and beyond: $125K to maintain	Needed (Ended – potential restart at later time)
	NOAA small business innovation research (SBIR) program is supporting new autonomous vehicle monitoring technology developments that could augment monitoring	NOAA SBIR	2 year – 233K, possibility for continuations	Needed – 0 Ends in FY21, with potential Continuations
Gliders	NOAA small business innovation research (SBIR) program is supporting new autonomous vehicle monitoring technology developments that could augment monitoring	NOAA SBIR	2 year – 233K, possibility for continuations	Research Project, will determine cost to operate
Bin 4: Characterization of hypoxia west of Mississippi Delta and south of Louisiana – Louisiana Coastal and Ocean Acidification Monitoring Workgroups				
	Monthly cross-shelf transects C and F	LUMCON; LSU	$80K/survey X 11 surveys = $880K	Needed
Ship surve	Monthly cross-shelf transect from Barataria Pass to hypoxic zone core (CSI-9)	Louisiana CPRA; LSU	50-100 k, depending on scope	Pilot - 25K (Gulf Star Award) for 2 yrs. Needed – 50 k per year

	Maintain observation system west of Miss Delta: CSI-9	GCOOS; LUMCON	Year 1: $100K for new probes and sondes (surface and bottom); Year 2 and beyond: $125K/yr to maintain	Needed
Observing systems	Maintain OAP observation buoy west of Miss Delta: CSI-6	NOAA OAR/OAP	$90,333/yr to maintain	In GCOOS budget through '22, but subject to OAP approval for FY18-FY20
	Maintain bottom oxygen observation system west of Miss Delta: CSI-6 if OAP buoy does not have bottom D.O. associated.	GCOOS; LUMCON	Year 1: $100K for new probes and sondes (surface and bottom); Year 2 and beyond: $125K/yr to maintain	Funded in FY17 and FY18 by NSF Needed: 2019 and beyond
	Maintain observation system south of Atchafalaya: **C**	GCOOS; TAMU	$125K	Needed
	Maintain observation system south of Atchafalaya: **C**	GCOOS; TAMU	$125K	Needed
Bin 5: Characterization of hypoxia along Texas coast – Texas Monitoring Workgroup				

	Need survey between June and August to evaluate anticipated May peak of hypoxia in region and to determine interaction with Miss R plume		$100K (6 days/Manta)	Needed
Ship survey	Flower Gardens (monthly Manta transect) - Note	TAMU	80K	Supported
	Maintain observation system west of Miss Delta at western part of shelf-wide grid: G	GCOOS; TAMU, NGOMEX	$125K	Needed: Platform still available, but support needed
Observing systems	TABS – how many required to fill out design.	TAMU		Lost 2 shelf buoys, in discussions to restore capacity Needed – 2 Buoys. Funded: 10 buoys are active
	Glider (2, Teledyne slocum) Liquid robotics wave glider (offers service to run, $250/day)	TAMU	30-60K / month Battery costs and running and recovery	Needed
Gliders	Glider (2, Teledyne slocum) Liquid robotics wave glider (offers service to run, $250/day)	TAMU	30-60K / month Battery costs and running and recovery	Needed.
Bin 6: Cross-regional monitoring – Fisheries, Autonomous Vehicles, and Gulf Restoration Monitoring Workgroups				

	SEAMAP groundfish survey mapping hypoxia from June through mid-July	NMFS; LDWF	$190K	Supported: NOAA NMFS ongoing
Ship survey	SEFSC Shark/Snapper/Grouper Bottom Longline Survey	NMFS	No cost reported	Supported. All surveys do not collect bottom dissolved oxygen.
	SEAMAP Ichthyoplankton Survey for the fall, spring, and winter	NMFS	No cost reported	Supported.
	Pelagic Acoustic Survey	NMFS	No cost reported	Supported.
	U.S. Gulf of Mexico Marine Mammal and Seabird Assessment for the summer and winter	NMFS	No cost reported	Supported.
	U.S. Atlantic Marine Mammal and Seabird Assessment for the summer and winter	NMFS	No cost reported	Supported.
	Add Altimeters to existing monitoring surveys to ensure bottom samples are collected	NMFS	Altimeter with connectors that can be used with a SeaBird 911 CTD runs around $4000	Supported: Added to Oregon II and the Pisces Need: Requested for Gordon Gunter

	Deploy gliders; "Area" approach of Glider Implementation Plan: 4 cross-shelf areas from June through Aug, with 10-day runs per area (2 underwater autonomous vehicles ["gliders"] & 1 autonomous surface vehicle [ASV] needed per area)	Ongoing Pilot Study: TAMU	equipment investment = $1.44M based on $960K for 8 gliders ($120K each) + $480K ($120K each) for 4 ASVs Deployment costs: $705K based on $8K/day for ship, $12K/day for personnel, $1K/day/glider, and $2.5K/day/ASV	Prior Support NOAA NGOMEX funding of Pilot Study in FY17 Needed: Year 1: $2.145M = $1.44M for equipment + $705K for deployment Year 2 and beyond: $705K for deployment
Data management	Maintain a data portal to make data accessible and to facilitate exchange (data management), and disseminate data and findings to research and management communities (comm.)	GCOOS; NCEI (including Hypoxia Watch); LSU/LUMCON	$125K for GCOOS FTE	Supported: by IOOS to GCOOS from FY16 to FY20
Data management	Maintain a data portal for data access and to facilitate exchange (data management), and disseminate data and findings to research and management communities (comm.)	GCOOS; NCEI (including Hypoxia Watch); LSU/LUMCON	$125K for NCEI FTE	Supported: NOAA NCEI ongoing
			$125K for LSU/LUMCON FTE	Supported by LSU/LUMCON in FY17 Needed: FY18 and beyond
			$125K for LSU/LUMCON FTE	Supported by LSU/LUMCON in FY17 Needed: FY18 and beyond

Total Annual Cost is not listed for this section, as all monitoring is not required, though a large number of these will be needed to be able to support these priorities as products 3-5 are not possible without a large monitoring program.
Total Data Management costs: 500k per year

- **Need FY18: $250, Need FY19: 250k, Need FY20:375k**

Workgroup Descriptions

The workshop included report-outs from each of the monitoring workgroups on their goals, current activities and successes, infrastructure and resource needs, and plans over the next 2-5 years to maintain or expand upon their activities. Workgroup summaries are provided below and are complementary to the progress and tracking documents maintained and updated by each of the workgroups with the following goals: (1) provides summaries of needs for upcoming "meetings/calls"; (2) identifies specific actions associated with information gathering for existing monitoring efforts that could be directly used or leveraged to include monitoring of nutrients and dissolved oxygen; and once informed, (3) guides the pursuit of obtaining relevant data or additional sampling components for existing infrastructure for the purpose of improving our understanding of current conditions and the anticipated future effects of restoration projects.

State of Louisiana Coastal Monitoring Workgroup

Workgroup Purpose: Develop a cooperative and sustainable nutrient monitoring program in Louisiana state coastal waters to complement Gulf-wide nutrient monitoring efforts.

The goals are to:

- Determine data needs/gaps for hypoxia monitoring in Louisiana coastal waters
- Develop proposals to address data needs/gaps that leverage existing data collection efforts and complement monitoring efforts in other Gulf states
    a. Identify requirements for a monitoring transect extending from nearshore to the core of the hypoxic zone that captures nutrient transformations, water quality changes, and resulting hypoxia dynamics to assess the effects of river diversions on nutrient delivery to the Gulf and dynamics of hypoxia
- Identify and secure funding for implementation of identified needs
    a. Identify mechanisms and opportunities to support the monitoring transect

1. Successes
    a. Identified a critical data need for nutrient monitoring in state waters
    b. Developed a proposal to address the urgent need to establish a monitoring transect extending from Barataria Pass to the inner shelf
        i. Necessary to establish baseline conditions and monitor far-field effects of proposed diversions
    c. Awarded a $50K Gulf of Mexico Alliance Grant that funds a portion of the monitoring transect

2. Current Activities.
    a. Working to fund the full transect monitoring proposal ($300K yr/15 years)

b. Submitted a project idea *Water Quality Offshore Monitoring Transect* to the Natural Resource Damage Assessment Open Ocean call for project ideas (5/15/2017, LCMW subgroup)
c. Identifying potential funding sources and developing a plan to secure funding for the full transect monitoring proposal

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States of Mississippi and Alabama Workgroup

Workgroup Purpose:

The goals are to:

- Compile coastal monitoring efforts for MS and AL and identify mechanisms to fill gaps in DO and pH monitoring capabilities
- Coordinate MS/AL monitoring activities and identify opportunities to transition these to a sustainable cooperative monitoring program
- Attain additional funding to aggregate existing datasets and determine historical temporal and spatial extent of hypoxia in the Mississippi Bight

- Provide easy access to visualizations of hypoxia conditions in the MS Bight for researchers and decision makers.

1. Successes
    a. Documented the extent, duration, and intensity of hypoxia in the region. Publication coming.
    b. Additional proposals will be submitted in 2019

2. Current Activities.
    a. Aggregate Existing Data
    b. Continue Current Activities:
        i. USM – Sustain continuous monitoring at essential fish habitats
        ii. LPBF- Seasonal surveys around Chandeleur Islands
        iii. DISL – (Primarily Mobile Bay) – 7 water quality stations and developing one offshore station (ARCOS)
        iv. All – Develop recommendations for "comprehensive" observations

3. Developed a proposal to support the compilation of existing data and to develop visualizations.
        i. Submitted to GOMA.
        ii. Consider additional sources for support.

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State of Texas Workgroup

Workgroup Purpose: To identify monitoring elements along the Texas coast and devise a plan to improve, expand, or leverage federal and state efforts related to hypoxia and related stressors.

The goals are to:

- Identify requirements of hypoxia monitoring plan for Texas
- Identify and Quantify sources of nutrients on the Texas coast
- Identify mechanisms that initiate and control the location, severity, and duration of Texas coastal hypoxia
- Identify mechanisms that differentiate MARS and Texas hypoxia

1. Successes
    a. Operational Glider deployments
        i. Slocum gliders
        ii. NOAA Funding
        iii. TCEQ Center of Excellence
    b. Hurricane Harvey Rapid Response
    c. Quantification of Slocum glider ability to reach near bottom waters

2. Current Activities
    a. Identify additional Members
        i. Steven F. DiMarco: Professor and Ocean Observing Team Lead, Geochemical and Environmental Research Group, Texas A&M University
        ii. Chip Breier, Associate Professor, School of Earth, Environmental, and Marine Sciences, The University of Texas Rio Grande Valley
        iii. David Hala: Assistant Professor, Department of Marine Biology | Texas A&M University at Galveston
        iv. Hussain A. Abdulla: Assistant Professor of Chemistry, Department of Physical & Environmental Sciences, Texas A&M University- Corpus Christi
    b. Identified relevant activities
        i. NOAA CSCOR: Glider Implementation Plan (July 2018)
        ii. Texas OneGulf Center of Excellence (WTX)

1. 2018 Field Campaign: Padre Island to Sabine

iii. NSF RAPID Awards: Hurricane Harvey (5 awards to TAMU)

iv. Repeat Transects: Galveston to FGBNMS
   1. TAMU: Observing the Ocean REU
   2. June cruise: RV Pelican
   3. RV Manta SCS dataset

v. Resources: MCH Atlas released (Dec 2017)
   1. http://mchatlas.tamu.edu

vi. Resources: http://pong.tamu.edu/tabswebsite

vii. Resources: Texas HF Radar Network, TABS

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Autonomous Vehicle Workgroup

Workgroup Purpose: The purpose is to identify strategies for the use of autonomous vehicles and to identify the potential of new and emerging technologies for applications to autonomous vehicles.

The goals are to:

- Determine applicability and best practices for autonomous vehicle deployments and use
- Determine sampling strategies and for effective and efficient monitoring
- Identify new sensor technologies and vehicles for Hypoxia monitoring of the northern Gulf of Mexico
- Engage stakeholders

1. Successes
   a. Slocum Glider deployments
   b. Liquid Robotics Wave Glider deployments
   c. C-Worker deployments

2. Current Activities
   a. Identified members
   b. Fill out shared document

c. Identify the most promising vehicles
    i. Teledyne Webb Research Slocum Gliders
    ii. Liquid Robotics Wave Rider (SV3)
    iii. ASV Global C-Worker series
    iv. Other vehicle considerations
        1. Kongsberg: Coastal Glider
        2. Spray
        3. MOST Autonaut
d. Current activities
    i. NOAA NCCOS CRP: Glider Implementation Plan (July 2018)
        1. Activities: Define Metrics, Capability, Monitoring Design, Resource Assessment, and Workforce Requirements.
    ii. Texas OneGulf Center of Excellence
        1. 2016-2018 Field Campaign
    iii. Galveston to FGBNMS Transect
        1. Private/Public Partnership with Liquid Robotics and Texas A&M University
    iv. Stones Array
        1. PPP Shell/Fugro/USM/TAMU
    v. Resources:
        1. GCOOS GANDALF glider data
        2. Stones Mooring
        3. NAS Loop Current Report
    vi. TAMU Mission Summary
        1. 34 missions, 800+ days, 15000 km traveled, 20 Coastal missions (< 200 m), 14 Deep missions (> 1000 m)

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Fisheries Monitoring Workgroup

Workgroup Purpose: The Fisheries Monitoring Workgroup has two goals that together aim to broaden understanding of the effects of hypoxia on key fisheries, for the purpose of quantifiably predicting hypoxia impacts and managing fisheries accordingly.

The goals are to:

- integrate fisheries surveys into the Cooperative Hypoxia Monitoring Program by leveraging and expanding upon current monitoring activities and compiling available data

- serve as a management advisory group (Management Committee) for two Northern Gulf of Mexico Ecosystems and Hypoxia Assessment Program (NGOMEX) projects, to help ensure the effectiveness of project tools and outputs towards fisheries management applications

1. Successes
    a. Additional data found.
    b. In a June gathering of several FMW members, it was realized that better depth readings with oxygen readings would improve the utility of SEAMAP cruises. Altimeters have since been added to SEAMAP vessels (2 of 3) for more accurate depth readings for CTD. Altimeters were added to the Oregon II and Pisces and used during the bottom trawl survey this year (2018). An altimeter has been requested for the Gordon Gunter.

2. Current Activities
    a. Synthesis report of federal fisheries surveys that include DO - to be included in Cooperative Hypoxia Monitoring Program progress report:
        i. Chris Gledhill sent the FMW a May 2017 summary compilation report, *NOAA Fisheries Independent Surveys on NOAA Ships*, that was prepared for the SEFSC Survey Assessment Workshop on 20-23 June 2017. In addition to the SEAMAP Groundfish Survey (p. 15), that is already an operational component of the Cooperative Hypoxia Monitoring Program, the following surveys collect DO and can be integrated as part of the Program:
            1. SEFSC Shark/Snapper/Grouper Bottom Longline (p. 4)
            2. SEAMAP Ichthyoplankton Survey for the fall (p. 7), spring (p. 9), and winter (p. 11)
            3. Pelagic Acoustic Survey (p. 21)
            4. U.S. Gulf of Mexico Marine Mammal and Seabird Assessment for the summer (p. 31) and winter (p. 33)
            5. U.S. Atlantic Marine Mammal and Seabird Assessment for the summer (p. 35) and winter (p. 37)
    b. ID of state fisheries surveys whose outputs could be integrated into Hypoxia Monitoring Program; include focus on LA state fisheries monitoring program
        i. Kirsten Larsen sent a link to Hypoxia Watch that includes a summary of the LDWF nearshore monitoring component of the SEAMAP Groundfish Survey, and DO data and maps from their surveys in 2013 and 2015.
    c. Explore the possibility of adding DO to key fisheries surveys – assess what it would take and who to contact
    d. SEDAR or other fisheries data or assessment workshops targeting menhaden, red snapper, or brown shrimp:

e. The shrimp assessments do not go through the SEDAR process and there are not a series of workshops. Rick H. basically updates the assessment on an annual basis and it goes to the SSC in April (Source: Kevin C. 01.19.2018 email)
f. Menhaden is undergoing a benchmark stock assessment this year (Data workshop, week of June 5; Assessment workshop, week of Aug 6; Review workshop, week of Nov 5). This will ultimately go to the Gulf States Marine Fisheries Commission (not the Gulf Council). (Source: Kevin C. 01.19.2018 email)

Members and Email Addresses

Interim Lead - Christopher Brown (NOAA/NESDIS)	christopher.w.brown@noaa.gov
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Gulf Restoration Workgroup

Workgroup Purpose: Identify opportunities for leveraging DWH-funded monitoring activities, including, but not limited to the RESTORE Council Monitoring and Assessment Program (CMAP), NRDA cross-TIG Monitoring and Adaptive Management WG (CTMAM), relevant RESTORE Act Science Program funded activities, and/or other restoration monitoring projects, with funded monitoring activities pursuant to the implementation of the Cooperative Hypoxia Monitoring Program.

The goals are to:

- Identify ways DWH-funded monitoring activities can support oxygen monitoring objectives of CHAMP
- Include and integrate appropriate CHAMP representatives into CMAP/GOMA Monitoring Community of Practice being established Summer 2018 to participate in the vetting of gap analyses, prioritization, and implementation planning
- Ensure the monitoring network coordinated by CMAP and other regional water quality monitoring activities that collect oxygen data, makes it available to CHAMP members in a timely manner

1. Current and Proposed Activities.
    a. Participate directly in RESTORE Council Monitoring and Assessment Program (CMAP) to identify and create leveraging opportunities
        i. CMAP status
            1. Initial funding for Phase I in place
            2. Facilitating monitoring coordination across Gulf restoration programs and development of minimum monitoring components
            3. Funding GOMA to facilitate creation of Gulf Monitoring Community of Practice in 2018
            4. Funding MS-AL SG to hold User workshops in 2018
            5. WQ and Habitat Long-term Monitoring Inventory (underway)
            6. Gap Analysis (in process)
            7. Establishment of Regional Monitoring CoP and network of existing programs
            8. Establishment of Monitoring Coordination Committee to coordinate and leverage restoration program and other funding for monitoring
    b. Determine funded research that is relevant to CHAMP.
        i. Relevant NOAA RESTORE Science Program FY17 Funded Projects
    c. Explore and evaluate leveraging opportunities with NRDA Cross-Trustee Implementation Group Monitoring and Adaptive Management Work Group activities
    d. Identify pending Gulf restoration activities with significant and relevant monitoring components (e.g., LA Mid-Barataria Sediment Diversion, project monitoring, modeling, and adaptive management framework)
    e. Update this document

Members and Email

Lead - Steve Giordano (NOAA NMFS)	steve.giordano@noaa.gov
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Hypoxia Task Force Workgroup

Workgroup Purpose: Maintain current monitoring and expand it to understand the role that nutrient reductions (N and P) other drivers have in reducing the size of the hypoxic zone towards its defined goals. There is also a desire to find ways to achieve additional monitoring activities to meet the data needs for advanced modeling that more holistically describes the system (i.e., support 3-D time variable models), and explains the impact of hypoxia on living resources, habitats, and people in a quantifiable way.

The goals are to:

- ID programmatic tools (strategic plans, budget projections, EFR budget, etc.) for improving upon and sustaining current efforts for hypoxia monitoring within agencies
- ID opportunities to forge new, or strengthen existing partnerships in a manner that will lead to long-term commitments to hypoxia monitoring program (e.g. interagency work groups, administration ocean plans)
- On implementation calls, report out HTF progress in modeling and monitoring activities;
- At HTF Coordinating Committee calls, report out progress of Implementation Team
- Ensure that the monitoring data needed to identify management progress for hypoxia is available

1. Successes
    a. Nutrient Loading Monitoring Support is secured (USGS committed).
    b. Hypoxia Annual Cruise Support (Short/medium commitment)
        i. Modeling commitment for FY20
        ii. Cruise commitment until FY20
    c. Discharge Monitoring (USACE Committed)

2. Current Activities
    a. Update HTF on CHAMP activities.
    b. Update CHAMP members on relevant HTF activities.
    c. Working towards SOP for Hypoxia Cruise
    d. Tripp Boone will be taking over for Danny Wiegand.

Members and email

Danny Wiegand (EPA Gulf Program)	Turning role over to Tripp
Tripp Boone EPA Gulf Program	Boone.Tripp@epa.gov
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Integrating Ocean Acidification and Hypoxia Monitoring (OA&Ho) *Revised 4 November 2018*

Workgroup Purpose: To facilitate increased awareness of ocean acidification in the Gulf of Mexico and to identify intersections among groups interested in monitoring ocean acidification parameters that benefit hypoxia monitoring.

The goals are to:

- Report out on and drive progress towards leveraging more bottom oxygen monitoring associated with shared goals of OA and other monitoring opportunities

1. Successes
   a. OA Buoy moved from outside of the MARB influenced hypoxic zone to inside of the zone (Howden) remains in place. Need: related bottom-water dissolved oxygen and pH
   b. The data are up on the PMEL site: https://www.pmel.noaa.gov/co2/story/Coastal+LA
      i. The functioning of the pH probe requires investigation
   c. Placement of Aanderaa optodes on platforms in deep water (DiMarco)
      i. Stones platform (3000 m), 3 with a WHOI GoMRI-funded project SW of Macondo site (1000 m)
      ii. All in bottom boundary layer
      iii. About a dozen more suitable for deployment on other moorings
   d. Completion of one-year of coupled DO, pCO2 and pH in situ deployments summer 2017 (Rabalais/Cai/Maiti)
      i. Collaboration of Cai and Rabalais with NSF support continued in 2018
      ii. Workshop held Feb 2018 at Ocean Sciences Meeting with this group and others working in northern Gulf of Mexico in summer 2017
      iii. pCO2 and pH deployments near station C6 in 2018; Cai graduate student onboard shelf-wide cruise for surface and bottom measurements
2. Future Needs
   a. Re-establish mooring east of Mississippi River (Howden)
   b. Establish bottom O_2 at OAP buoy in middle of northern Gulf of Mexico hypoxic near C6C along with other sensors (Howden et al.)
   c. Coordinate potential NSF/U Delaware/LUMCON/LSU Ocean Acidification and Hypoxia work on the Louisiana shelf for hypoxia season 2019
   d. Shelfwide hypoxia monitoring cruise, July 2019
   e. Provide information to Mississippi River Nutrient/Hypoxia Task force
   f. Identify additional initiatives

3. On Hold
   a. Identification of oil and gas platforms via BOEM for encouraged OA monitoring (bottom O_2 remains an issue)

Members and Email

Lead - Barb Kirkpatrick (GCOOS)	barb.kirkpatrick@gcoos.org
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N.B. the GCAN network includes many more individuals from all five Gulf states

Data Management Plan

There are two principle organizations that serve as repositories and ensure the availability of long-term ocean observing data in the Gulf of Mexico. These include the NOAA National Centers of Environmental Information (NCEI) and the Gulf Coat Ocean Observing System (GCOOS), which is the gulf regional association of the Integrated Ocean Observing system (IOOS). NCEI principally operates as a long-term digital repository for observations, while GCOOS operates as a data portal that functions to make data available in similar format to improve the usability of the data. NCEI and GCOOS transmit data between each other, though the exact delivery mechanism varies. For this reason, data management descriptions or transmission flow charts, must be described for each relevant data stream source from autonomous vehicles, buoys, ships, etc. Data storage processes have been outlined for Hypoxia Watch (Figure 1) and the CTD Grabber Program (Figure 2).

A number of recommendations have been discussed since the original whitepaper. First, it remains that there is no single location where full water column oxygen profiles or bottom oxygen data can be garnered for the Gulf of Mexico. This could be addressed through the maintenance of a hypoxia data portal. At the 7th annual workshop, some hypoxia investigators did indicate that there are not that many monitoring activities that collect near bottom dissolved oxygen, however that sentiment may overlook some state and relatively new monitoring efforts. To maximize CHAMP integration, a hypoxia portal should be considered further, though financial support may be needed. A second general point was reiterated from the original white paper, “all funded monitoring activities by CHAMP members should be accompanied by dedicated support for data management, ensuring the quality and availability of the collected data.” These general aspects of data monitoring should be addressed prior to the next workshop.

More specific recommendations included, that all CHAMP members that use gliders and other autonomous vehicles are recommended to deliver mission data to GCOOS for display on Gulf AUV Network and Data Archive Long-term storage Facility (GANDALF), while full datasets should be sent to NCEI. In development, is the ability for full data transmission to NCEI through the IOOS Glider DAC. Along these lines, it was noted that the hypoxia data is not served by IOOS to the Global Telecommunication Service (GTS), something that would be needed if any models on hypoxia would be made operational at regular time scales (e.g., daily to weekly).

Data Management Figures

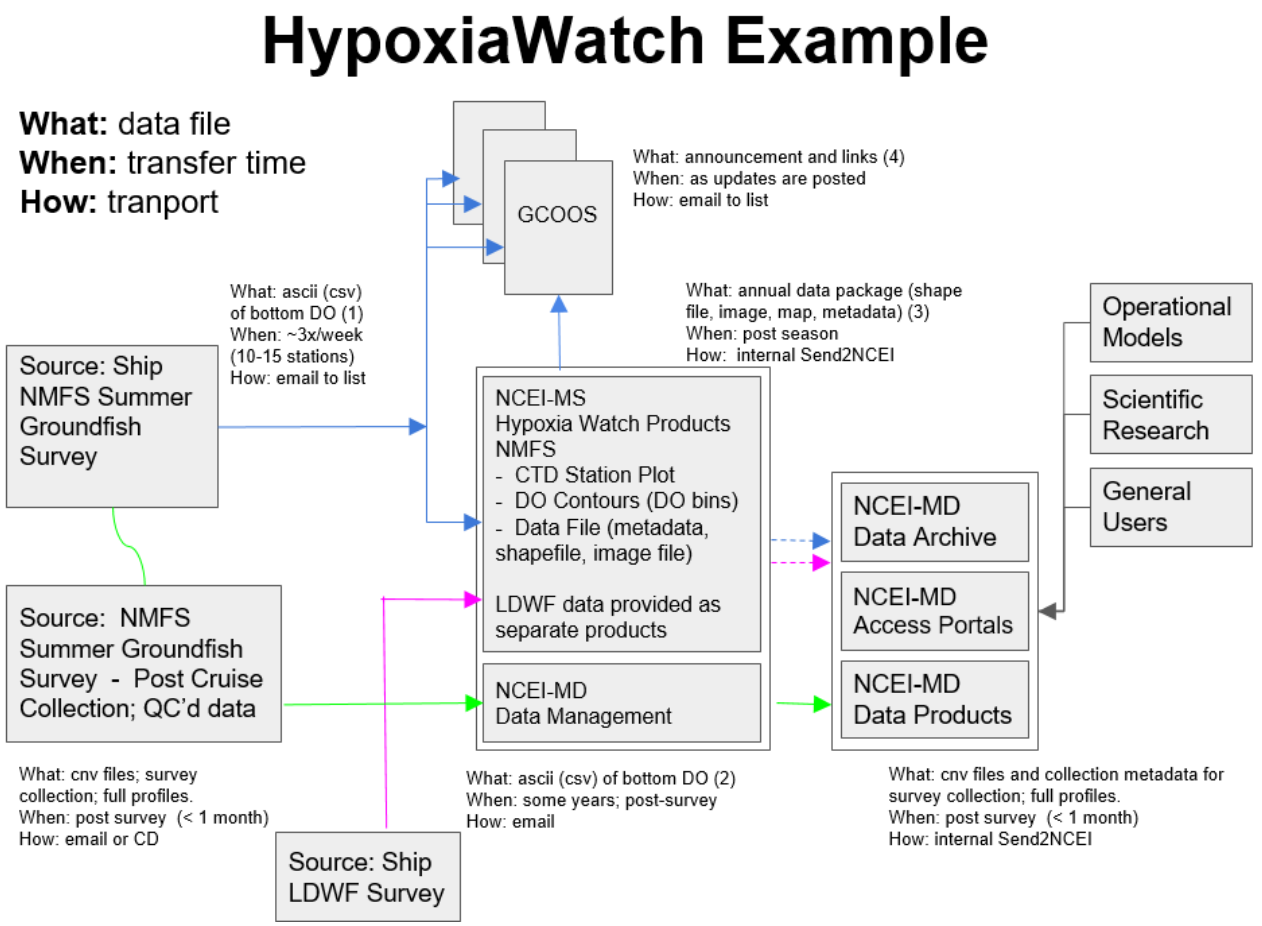
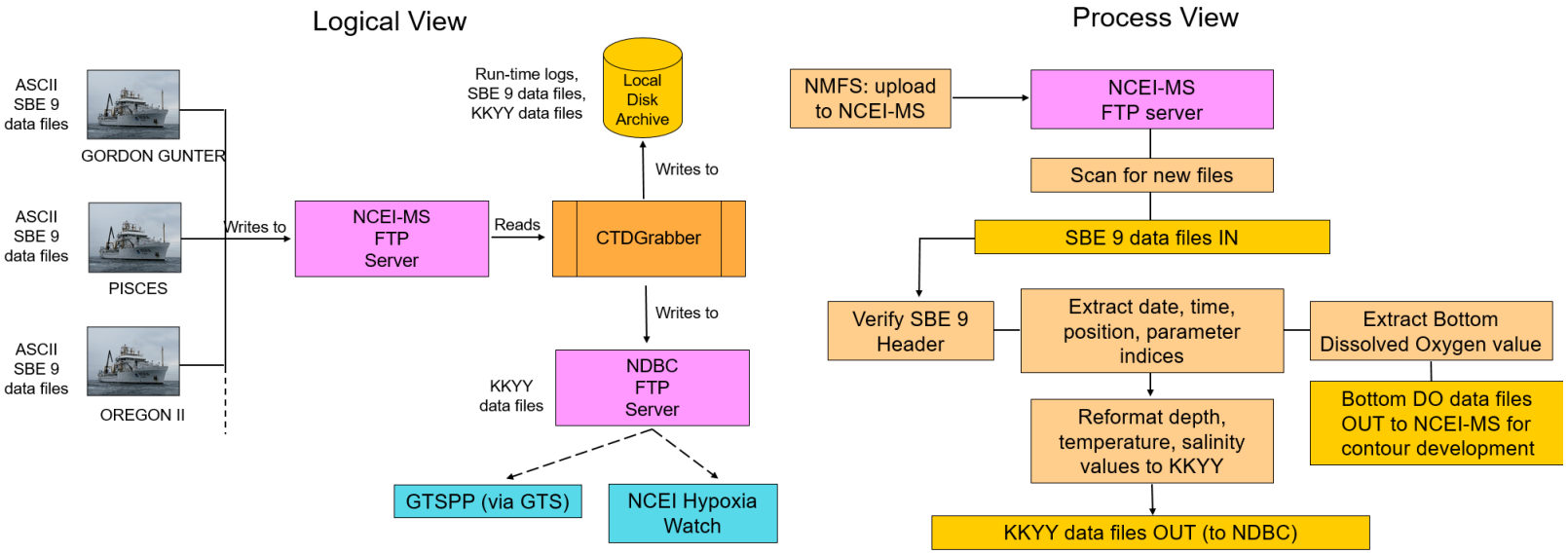


Figure 1. This data management figure outlines the process for how hypoxia watch receives, shares, and archives data. Clear data management paths are important to ensure effective distribution of datasets.

CTD Grabber



Figures 2. The figure outlines the process for how data collected via CTD casts on the NOAA ships Gordon Gunter, Pisces, and Oregon III are both archived locally and transferred by the CTD grabber for archival and dissemination to related programs that utilize and distribute the data (i.e., Hypoxia Watch, Figure 1). The logical view generally maps the data pathway, while the process view explains the actions that occur**.**

List of Workshop Attendees (SC = Workshop Steering Committee)

Becky Allee	NOAA RESTORE
Steve Ashby (SC)	NGI
Chris Brown (SC)	NOAA NESDIS
Steve DiMarco	TAMU
Brian Dzwonkowski	USA/DISL
Katie Flahive	EPA OWOW
Angelina Freeman	LA CPRA
Steve Giordano	NOAA NMFS
Stephan Howden	USM
Jonathan Jackson	NGI
Lauren Jackson	NGI
Dubravko Justić	LSU
Barb Kirkpatrick	TAMU GCOOS
Kirsten Larsen (SC)	NOAA NCEI
Alan Lewitus (SC)	NOAA NOS
Kathy Martinolich	NGI
Trevor Meckley (SC)	NOAA NOS
Nancy Rabalais	LSU, LUMCON
Angela Sallis	NOAA NCEI
David Scheurer (SC)	NOAA NOS
Danny Wiegand	EPA Gulf Program

Left to Right: Steven Dimarco, Stephen Howden, David Scheurer, Barb Kirpatrick, Brian Dzwonkowski, Alan Lewitus, Dubravko Justic, Steve Ashby, Steve Giordano, Chris Brown, Nancy Rabalais, Trevor Meckley, Kirsten Larsen, Danny Wiegand, Angela Sallis.