

## B Appendix: Proposed Research Questions and Necessary New Data

### B.1 All research questions developed by the Baseline Studies working group, including new data needed to answer the questions, entities that are likely to collect the data, and relevant existing data in the inventory.

Subject Category: Corals & Hard Bottoms

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
Where are the sensitive biological components? Benthic habitats (natural and artificial)?	Review of existing oil and gas data; new surveys to locate new areas; oral histories with fishermen	Research Groups - UNAM, UV, CINVESTA, Mérida	Search O&G data
What is known about genetic/ecological connectivity among reef populations?	1) Collect tissue samples of flag species. 2) Do genetic studies. 3) Correlate information among reef sites	BOEM, NOAA, UNAM, UV	Smithsonian genetic database
What is the impact of high suspended solids on populations/communities in the Southern GOM's reefs?	1) Look for reefs not influenced by sedimentation like Florida, Campeche Bank, or Cuba. 2) Compare performance of Flag species 3) Characterize land use	BOEM, NOAA, UNAM, UV, CIM/Univ. of Havana	Community structure data is available for several Southern GOM reefs; AGRRA reports
Is the inventory of reef species finished in the Southern GOM?	1) It is necessary to continue the collection of specimens almost in all reef sites 2) Also to involve more taxonomists	UNDM, CINVESTAV, UV	CONABIO, ICMYL databases; CINVESTAV
Are shipwrecks and platforms acting as artificial reefs in the Southern GOM as they are in the northern GOM?	Locate and document shipwreck sites; Develop shipwreck database; Investigate platforms and artificial reefs for comparison	BOEM, NOAA, UNAM, Veracruz Port Authority; INAH, UV, National Fisheries Institute of Mexico	Grounding database 1950s-2016 (Mexico) AWOIS; Artificial Reef programs
How is erosion facilitating the decline of reef growth and reef related species while promoting algae reef growth?	Establish control study sites; Water quality sampling over sites; Program for repeated sampling; Bio-erosion testing	—	—

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
What is the spatial pattern of diseases, bleaching, and coral coves?	Collect initial data; Develop long-term program - yearly at end of summer	BOEM, NOAA, U.S. State Fisheries, UV, UNA	Previous monitoring data to assess historical changes
Condition of reefs changed over time - shallow/deep	Coral cover and abundance; fish abundance and size; Aims and AGRRA monitoring; squid pots fisheries production monitoring; acoustics	UNAM, UV, UADT	AGRRA; REEF
What is the baseline acoustic environment of the sensitive habitats?	Baseline soundscape of specific reefs/habitats	UNAM, UV, UADT	NOAA?
Are shipwrecks and platforms acting as vectors for invasive species?	—	—	—
What are the impacts of bottom temperatures on sensitive species?	—	—	—
How is the sediment influx from the larger Gulf region impacting the sensitive habitats?	—	—	—

Subject Category: Infauna/Meiofauna

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
What are the species in the Gulf (regional scale)?	We need species list data to fill in gaps regionally. We also need corresponding taxonomic work.	Most information from academic sources	Varied data/ references from inventory
Can we increase the genomic database for known species?	We need new/fresh samples for DNA analysis. Preserved samples are not useful.	Academic sources again; lesser part environmental agencies??	Some inventory references are using eDNA already
What are the scales of temporal variability for community structure/species diversity?	We need to start monitoring projects to document this. We need fresh samples and processing power to handle this.	Academia	Varied
What is the functional role of infauna/meiofauna?	Field and experimental studies	Academia	Varied
What ecosystem services are provided by infauna/meiofauna?	We need field and socioeconomic studies	Academia	Varied
How do infauna/meiofauna contribute to systemwide productivity?	We need to analyze data we already have, but also supplement them with new studies	Academia	Unknown
Connectivity among populations on seafloor communities	—	—	—
What are the fauna associated with sargassam?	—	—	—
Which is the meiofauna/infauna in mesophotic coral reefs?	—	—	—

Subject Category: Demersal Fish

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
Mapping of benthic resources (habitat) and fish abundance distributions across the entire Gulf of Mexico - on a fine spatial scale - fill holes between existing studies.	Bathymetry and habitat characterization (perhaps using drop camera gear). Create a "fish base" inventory of the Gulf of Mexico	Interagency, and intergovernmental collaboration, where each group contributes personnel and funds, including academics	Hold workshop on mapping or habitat characterization to identify gaps, and see if data can be combined to help keep maps current
Historical reconstruction of data by reviewing all journals and manuscripts, both peer review and not, in English and Spanish	Develop "State of and History of GOM Resources" authored by experts from each country.	Academic institution led most likely	Review historical
Connectivity of species and communities around the entire Gulf i.e. what are the distributions across space and time, and abundances, and what factors drive these distributions?	Genetics data, egg and larval dispersal models	Academics, NOAA, Mexican and Cuban partners	—
What is the distribution of fish larvae across the Gulf? What is adult connectivity?	Satellite data, current models, etc.	Academics, NOAA, satellite data	See modeling efforts of Claire Paris - Univ. of Miami; See also Mandy Karnauskas
Gather recreational fishing data for all 3 countries. Tease out recreational from subsistence and collect data on both	Landings, age structure and length structure of catches	Government agencies	—
How to balance needs of humans and ecosystems?	—	—	—
What are regulatory processes in all 3 countries that are effective management and ineffective management i.e. what works and what doesn't with respect to human needs and ecosystem?	Collect data on socioeconomics	—	Satellite primary productivity
Are there true eco-regions, substrate differences? What would layers go into categorizing regions?	Shallow and deepwater maps needed for Southern Gulf	—	—
Gather baseline data on deepwater Gulf: inventory, connectivity with shallow species i.e. abyssal plane of Gulf, if another spill, how would it affect deep species?	—	BOEM, BP, Shell, Chevron, Exxon, etc.	—
Role of sargassum in Gulf of Mexico and its role in connectivity, larval fish survival, etc.	—	—	—
What is more important to fish connectivity: transfer roles of egg/larvae, ontogenetic migration or adult movement?	—	—	—

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
Transboundary assessment of shared stocks across the GOM LME: Cuba, Mexico and United States.	–	–	–
Do we know all of the fish species that live in the Gulf?	–	–	–
Importance of estuaries to fish stocks, and quality of estuaries, and whether poor quality estuaries affect adult populations offshore	–	–	–
Define nursery habitat/regions/areas for Gulf of Mexico (i.e. seagrass, mangroves)	–	–	–
Comparative sites and entire GOM LME where you do longitudinal sampling for comparison purposes	–	–	–
Understand larval stages, and phenology of coral reef fish recruitment - implications for oil spill effects, etc. that may affect plankton/surface water	–	–	–

Subject Category: Pelagic Ecology

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
Identification of critical habitats of different life stages of commercially important and endangered species	Centralized information of areas and species	–	–
How many no-take fishing zones exist? Do they work? Do they contribute to fish/coral conservation?	Fish aggregation areas; no-take fish areas inventory	CONANP; INAPESCA; Universidad Veracruzana	Unsure
Role of sargassum in the ecosystem, distribution and abundance	Distribution and movement of sargassum beds	CINVESTAV-CIGOM	None Found
Basic Biology of commercial and endangered species	–	–	–
Impacts of chronic oil pollution	Whole body assays; study design for sampling	NOAA, GOMRI, NAS	–
What supports primary and secondary production at different temporal and spatial scales/food web structure & dynamics?	–	–	–
Significance and importance of invasive species	–	–	–
Connectivity studies of migratory and endangered species	–	–	–
Longitudinal comparative studies involving commercially and recreationally important fish species (tri-national)	(individual & population level) Fish & species stress, health indices, reproductive data	Academic & NGO (Baylor, COBI)	None exists
Population genetics and connectivity studies of migratory and endangered species	Molecular markers (microsatellites, mtDNA, etc.)	Academic & NGO (CiGOM)	Numerical modeling (currents)
Joint stock assessments of commercially important fish and recreationally important fish	Comparable data sets	NOAA/NMFS; INA PESCA; & Cuban equivalent	None Found
Health indices of marine mammals (e.g., microbiome, documenting fishery interactions, pollutants) based on strandings	Collecting stranded marine mammals through coordination of trinational stranding response networks	NOAA/NMFS; INA PESCA; & Cuban equivalent; Mexico - individual response groups, Dr. Eduardo Morteo, Universidad Veracruzana - Blood analysis of dolphins in Cuba database, Acuario Nacional de Cuba	None Found

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
Harmful algal blooms, mechanisms of formation and species distribution	<a href="https://redfan.cicese.mx/">https://redfan.cicese.mx/</a>	REDFAN; GEF - Alejandra Navarrete	None Found
Documenting microbial communities and microbial processes	Gulfwide surveys with genetic markers	CIGOM Dra. Leopoldina Aguirre; University of Georgia, Samantha Joye; Liliana Pardo IBT; Alexei Licea, CICESE; José Quinatzin García Maldonado, CINVESTAV	None Found
Linkages between deep sea and coastal waters	–	Academics	–
What are the impacts of temperature anomalies on the ecosystem?	–	Academics	–
Food web dynamics in the pelagic zone. Identify stressors on food sources for commercially and recreationally important species	–	Academics	–
Primary production and reproduction hot spots monitoring, identification, and protection	Imaging data	Heyman, W. LGL	None Found

Subject Category: Water Quality & Seagrasses

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
Is there aquaculture or expected growth in aquaculture and what are the outcomes (potential)?	Economic data on aquaculture locations	–	–
How does sediment loading vary and what factors drive that variation? Positive - marsh accretion; negative - lower(?) seagrass	Sediment loads from major rivers/tributaries (can be remotely sensed); Factors: dredging, shrimp net dragging	–	–
How does gradual sea-level rise impact distribution of seagrasses (e.g., tidal flats being replaced by seagrasses)?	Distribution data over time with elevation/bathymetric data	–	–
How do low frequency but high impact events like hurricanes influence baselines? Are shifts temporary or permanent?	Before and after datasets for hurricane impacted regions	–	–
What indicators and/or representative sites should be selected for targeted and monitoring research to serve as a proxy for region?	–	–	–
What is the relationship between development, water quality, and seagrass cover?	Percentage of waste water treated and how that is changing over time	–	–
How does seagrass influence carbon cycling/carbon sequestration & where is it located?	–	–	–
What are the species-specific tolerances to salinity, temperature, water quality, and seagrass cover?	Factorial experiments; Look at tolerances	–	–
What is the proper scale for mapping seagrasses?	Data at different scales matched to degree of fragmentation	–	–
What is present land use/land cover and how is it changing over time (drives water quality changes)?	Data is already being collected; Analysis is the issue along with the resolution of remotely sensed data	–	–
How is water quality changing over time?	Continual monitoring of water quality (permanent system)	CONAGUA (Water Commission); IMTA (Water Technology Insti); SEMARNAT SEMAR (Ministry of Navy)	CONAGUA; IMTA datasets; SEMAR
Mangroves are an important habitat. Do they fit into this subgroup?	–	–	–
What drives interannual variability in seagrass cover?	Regular monitoring at specific sites over time	–	–
How do winter storms impact seagrass?	Winter data on wave energy and changes in seagrass cover	–	–



Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
What level of wastewater treatment occurs in the region and how will that change over time? What is the impact on water quality?	Comprehensive dataset on waste water treatment and monitoring of outfalls, especially during storms that push out lots of untreated storm water runoff	—	—
What percentage of nutrient loading is from groundwater discharge?	—	—	—
What is the role of epiphytes and organisms associated with seagrasses in nutrient processing within seagrass beds?	—	—	—
What is the current distribution of seagrasses? How does it vary interannually? What drives that variability (natural and anthropogenic)?	—	—	—

Subject Category: Geology & Physical Processes

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
Compile long-term bottom temperature records from deep sea	Need for additional moorings	ASEA should require EIS performed by Mexican academia; CONACyT, NOAA, BOEM, Industry, GOMRI, Academia, NSF, CICESE/CiGOM, ICML	Comb existing reports for unpublished records; CICESE...?
Ventilation of deep Gulf	CFCs; Maintain deep moorings	NSF, BOEM, NOAA, Industry, GOMRI, TAMU, CICESE/CIGOM	Deep Moorings 2006-2016
Loop Current Intrusion and eddy Separation, Energy transfer to deep	Mass balance between Yucatan Channel and FL Straits	NAS, BOEM, NOAA, Industry, Academic, CICESE/GiCOM/Rosentheil ICML	Loop study from BOEM Modeling output
General circulator models to inform carbon fluxes	verify models, biogeochemical models, hydrogen & carbon fluxes using long-term moorings	NSF, BOEM, NOAA, GOMA, NAS, Industry, CICESE	Existing model output; Nitrogen & Carbon Date (CIGOM); Existing moorings
How existing shelf data can be employed to study deep water. Assess/study sediment routes, distribution in time.	Shelf and slope concurrent measurements to establish link(s).	NOAA, Mexican Government, CICESE, ICML	Mexican Inst. Of Transport, PEMEX
High Resolution Bathymetry; Major issues/gap is access to existing data; Include substrate types in the deep Gulf	–	PEMEX; Industry; Government; University of Tamaulipas Instituto Mexicano Del Petroleo Secretaria de Marina	Access to existing data!!!
SAR Climatology of Sea State	None	NASA, NOAA	SAR Images in NESDIS (NOOA)
Sea-level impacts for SGOM; What are the local and regional impacts of sea level changes in the Gulf?	Tide guage; Coastal morphology; Data access; Lidar	USGS/NOAA, NSF, UNAM, SEMAR, INECC, CiiMAR-GOMC	UNAM, NAVI

## B.2 All research questions developed by the Environmental Monitoring working group including: new data needed to answer the questions, entities that are likely to collect the data, and relevant existing data in the inventory

Subject Category: Corals, Hard Bottoms, & Seagrasses

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
What is the status of stony corals in the SGOM? What restoration is in effect? What is the efficacy of restoration?	Spatial distribution of stony coral; reef fishes; role of habitat; cover depends on life stage of fish	Collaborative effort of country's agencies, government agencies, universities, research centers	Some mapping in the US; NOAA; Nature Conservancy in the Gulf
Status of reef fish resources in the region?	Fish spawning information (gap)/aggregations	SEMARNAT-CONABIO	—
Where are fish spawn aggregation spots? What are their geomorphological characteristics?	Physical flow geomorphology; Understanding gyres and eddies	—	—
Interconnectivity of currents in the Gulf and how it drives habitat connectivity?	Genetic exchange; Population dynamics	—	Nature Conservancy - larval dispersion model
Analyze connectivity between shallow and deep-water coral systems	—	—	—
Assessment of management of protected areas? Are they working for particular species?	—	—	—
Extent and effects of coral disease/bleaching events/climate change	Temperature; Salinity; Coverage; Rugosity	—	—
Status and recovery of <i>Diadema</i> in hardbottom habitat plus other indicator organisms	<i>Diadema</i>	—	—
Socioeconomic assessment of coral resources	—	—	—

Subject Category: Infauna/Meiofauna

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
Laguna Madre de Tamaulipas, Laguna Tamiahua and other small lagoon systems, Laguna La Mancha, Alvarado area	Anything seagrass cover, etc.; Sediment quality, benthic or epibenthic	–	Nothing to speak of; some Laguna Madre de Tamaulipas data
Holistic overview of Gulf benthic boundary	Any biological data at boundary	NOAA; University	Some, especially OCS STOCs, Less in Southern GOM
How do you use genomics to inform decisions?	Tissues	USGS; BOEM; NOAA; NSF & Smithsonian; GGI-Oceans	Nothing
Predictive distribution modeling especially in SGOM (species habitat)	More species data	NOAA; University Genome groups	Some species data distribution; OBIS
Assessments of stress-prone benthic communities, especially acute stresses vs chronic affects	Some ongoing experiments at different time scales, Campeche Sound, INAPESCA	INAPESCA; Universities; GOMRI	Ongoing experiments
Sea level effects (climate change) on intertidal communities	Comparison of intertidal community	–	Some, not much
Connectivity with Shoreline ↔ Open Ocean	–	–	–
Developed vs Underdeveloped Shorelines (mangroves-beachy)	–	–	–
Fishery species - Benthic conch-lobster whelk-seacucumber - urchin gonads	–	–	–
How do larval hotspots disperse into the Gulf as a whole?	–	–	–
Temporal dynamics at any scale	–	–	–

Subject Category: Demersal Fish

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
What are deepwater Lionfish populations & impacts?	—	—	—
What are trends in diversity age/growth & reproduction of fish over time?	—	—	—
What are populations and impacts of non-native damsel ( <i>N. cyanomos</i> ) in the Western Gulf?	—	—	—
How are fish distributions changing with climate?	—	—	—
What is larval fish connectivity between the United States, Cuba and Mexico?	—	—	—
What are locations, seasonality, and status of spawning aggregations?	—	—	—
Connectivity in-shore, off-shore within, and among regions?	—	—	—
What is extent/location of benthic habitat types among regions?	—	—	—
What are differences in fishing effort/landings/mortality among regions-commercial and recreational?	—	—	—
What are the effects of MPAs on fish community structure?	—	—	—

Subject Category: Pelagic Ecology

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
What is the status of Gulf pelagic fish stocks and is it changing (including biodiversity, abundance, production, habitat, movement, & larval dispersion)?	Fisheries independent; Illegal fishing estimates; SeaWatch; REEF; Global Fish Watch	Cuba - CIM-UH, MINAL/CIP & Academics; INAPESCA (Fisheries dependant); CIGOM; Academic (UNAM, ECOSUR, CINVESTAV) US Universities; Tri-national stock assessment workshops	Accessibility & QA/QC of data questionable; Level of uncertainty with existing data; CIGOM
What is the population status of marine mammals, turtles, birds, and manatees?	Stock assessments; visual aerial surveys; migratory; acoustics/tagging; nesting; IDs	CINVESTAV, CONABIO, CONAMP, PRONATURA (NGO), Cuba agencies; Gladys Porter, CIGOM	Marine mammal observations from oil and gas permits; CONABIO & CONAMP, MINAL/CIP, CIGOM, Vicente Guzman, CONANP; USGS tagging and genetic data
What are the oceanographic processes driving pelagic ecology (e.g. Loop Current & eddies)?	Baseline physical dynamics (i.e. circulation); monitoring of eddies shed from Loop Current & info on pelagic fauna; acoustics technology on AUVs	CICESE, NOAA (satellite), Universities & others using telemetry; SENAR?, ICIMAR (Cuba)	Physical oceanographic surveys; satellites; remote sensing; HYCOM models (other circulation models)
What is the distribution and movement of sargassum (sea turtles connection to)?	Sargassum origin (geographically), distribution, and abundance	Cuba: CIM, ICIMAR; Mexico: PRONATURA, UABC, CINVESTA, UNAM, CIGOM	Jim Franks (Gulf Research Lab, Alabama); Don Johnson (NRL Stennis)

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
What are hot spots (open ocean) for pelagic biodiversity?	–	TNC, SeaWatch; Mexico: Lauren Camillo	TNC
Where are important areas for pelagic invertebrates (including distribution, movement, etc.)?	–	–	–
What is the role of the Southern GOM and Caribbean as nursery for pelagics?	–	–	–
What is the overall distribution, role, and balance of lower trophic levels in Southern GOM (bacteria, phyto- and zooplankton) (e.g. carbon dynamics, primary production, microbial loops and HABs)	Microbial loop observations; role balance, etc.; models, CIGOM consortia is already doing	–	–
How does climate affect pelagic ecology and ecosystem?	–	–	–
Deep sea? What is out there? How is surface connected to deep? Connectivity/Interconnectivity	–	–	–

Subject Category: Water Quality

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
Socio-economics of current conditions vs. loss of ecosystem health and loss of income (fisheries, tourism)	–	–	–
Ocean acidification and coral reefs (warming, bleaching)	–	–	–
Upwelling → productivity; pCO <sub>2</sub> changes → ocean acidification?	–	–	–
Expand ocean acidification studies across the borders	–	–	–
Identification, via different methods, of contaminants and their uptake and accumulation in living resources	–	–	–
Human activity in watershed shifts to nutrient loading & worsening water quality, hypoxia, HABs, toxins, turbidity – “clear” linkages	–	–	–
Socio-economic conflicts & limitations between ecosystem health and economic growth with “development” money to communities, tourism, cruise ships?	–	–	–
Expansion of oil and gas in Mexico and Cuba and water quality, human communities, socioeconomic balance	–	–	–
What are the environmental conditions in Cuba, status of estuaries, and nearshore environments?	–	–	–
Socio-political differences and shifts thereof among GOMx countries with regard to business opportunities and development and environmental health	–	–	–
What are our priorities that environmental monitoring needs to address: Physical processes, habitats, organism status?	–	–	–
How pervasive and where hypoxia occurs, especially in southern GoM?	Comb all institutions	Mexico agencies	Very little
HABs/shellfish monitoring for toxins	more geographic coverage	–	USFDA for sources; UJAT “Olga” Pina?
Nutrient inputs, sediments to near coastal	–	–	Studies on Usamacinta-Gujalva River; UNAM; UJAT
Water quality → ecosystem health → ecosystem services	–	–	–
Tread carefully with beach condition reports	–	–	–
Sociological disconnect of increased population growth and tourism with degrading water quality	–	–	–
Impervious land → flooding → water quality	–	–	–
Expansion of oil and gas in southern GoM with water quality, hydrocarbons, spills, pipelines.	Hydrocarbon fingerprint of oil and gas products by industry	–	–
Protocols for water quality testing for uniformity	–	–	–



Subject Category: Geology & Physical Process

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
What are the five variables of interest to determine changes over time to the open ocean Gulf ecosystem?	CO <sub>2</sub> , pH, primary productivity, nutrient dynamics, physics, species diversity with time	NSF, NOAA, BOEM, NAS	–
What is the sediment methane and petroleum contribution to the water column budget?	Sea floor gas hydrate and petroleum. Seismic database; carbon isotope, geochemistry	NSF, NOAA, BOEM	Several publications
Dynamics of Loop Current?	Multiple platforms	–	Physical oceanography campaigns
To develop a sufficient sediment distribution map of coastal Gulf of Mexico	Sedimentological and elevation data; Northern GOM studies	USGS, BOEM, States, Mexico, Cuba	LA CPRA map of sediment distribution
What are the interchange patterns at the Florida Strait and the Yucatan Channel? What is the total transport? In addition, how the spatially resolved interchange pattern relates to the Loop Current.	High frequency radar maps; Mooring array at Florida Straits	Should be trilateral: CONACYT, NSF, Cuba research?	Several years of mooring array at the Yucatan Channel measured by CICESE; A cable (submarine) which crosses from Cuba to Florida and measures total transport
How do the environmental assessment processes in the United States and Mexico compare and how can common standards and practices be most effectively applied in the hydrocarbon producing regions in the GOM?	Legal and policy information from the two nations	BOEM, NOAA, BSEE, Dept. of State, ASEA, Hydrocarbon Commission of Mexico, Ministry of Energy of Mexico, Foreign Ministry of Mexico	2012 Legal framework for offshore operations of Mexican Oil industry - outdated due to energy reforms of 2013
How does the ventilation process work in the Gulf of Mexico in the intermediate and deep water?	Radiotracers and chemical tracers of intermediate and deep ocean circulation	CONACyT, NSF, BOEM	Oxygen and heat content though limited to establish ventilation rates

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
How do the small-scale processes interact with large scale processes (physical oceanographic processes)?	Fine scale hydrographic and circulation platforms with multiple sensors	NOAA, NSF; Mexico: CONACYT	Existing oceanographic campaigns, numerical model results, mooring observations

### B.3 All research questions developed by the Fates and Effects working group, including new data needed to answer the questions, entities that are likely to collect the data, and relevant existing data in the inventory

Subject Category: Corals, Hard Bottoms, & Seagrasses

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
How dependent are coastal communities on coastal and marine ecosystems? Does the adoption of "sustainable" practices increase this relationship?	—	—	—
How do invasives/stressors/pressure affect frequency and intensity of invasions?	—	—	—
Understanding how stressors/pressures affect biodiversity	—	—	—
On what scale should research be conducted to inform decisions?	—	—	—
How does sewage treatment practices affect coral, hard bottom, and seagrass?	—	—	—
What are the best restoration strategies to increase coral, hard bottom, and seagrass?	—	—	—
How do you define vulnerability of these habitats & quantify it for targeted conservation?	—	—	—
What are the relevant inputs (nutrients & pollutants)? How do we quantify & understand their fate?	—	—	—
Strategies for MPA & corridors for coral, hard bottom, and seagrass preservation	—	—	—
Get info to local scientists w/r/t government agencies/International agreements & relationships	—	—	—
What is the current distribution of seagrass, hardbottom, and coral throughout the GOM?	Lots, LIDAR, Multi-beam, side scan, visual survey, Seems to be less data in Mexico EEZ based on limited participation in this group	NOAA, USGS, Mexican counterparts, Universities	—
How do we scale models to understand local impacts, and inversely, to understand how local changes affect regional ecosystems?	Local mechanistic process studies, model parameterization for local scales?	—	—
How to best site artificial reefs based on environmental & social conditions?	Oceanography, water quality, social indicators (fishing, tourism), fish counts, all should use BACI tests & Active Adaptive Management	—	—
How do we accurately quantify cumulative human impacts throughout the GOM?	Atmospheric inputs, terrestrial inputs, and marine inputs, and benthic/geologic inputs	—	—

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
How do these cumulative impacts affect these habitats and associated fisheries?	Long-term & transect lines from highly impacted to pristine sites- long-term spatially explicit fish data-management & fishing practices	—	—
How do these changes in habitat & fisheries affect adjacent socioeconomics?	Local-scale data on employment, income, ecosystem services, & human well-being	—	—
How should we apply informatics to improve our understanding, characterization, & management of GOM?	Single integrated database & gap analysis (super computers)	—	—
How do we integrate across Ecosystem components & spatial/temporal scales?	Single integrated database & gap analysis (super computers)	—	—
What are the impacts of acidification on the coral, hard bottom, and seagrass & how does that vary due to environmental condition, habitat characteristics?	High temporal & spatial long-term data on the carbon cycle; adaptation-based data on organism response-impacts on all life stages, especially juvenile, embryonic, larval, & reproductive stages	—	—
What are the impacts of coastal communities on coral, hard bottom, and seagrass? How do the relative adoption of sustainability practices affect these impacts?	Data on local governance, ordinances, and practices (or lack thereof); perception of local communities on coral, hard bottom, seagrass health; data on enforcement	—	—
Ideas to incorporate humans as part of the ecosystem not external to the system	—	—	—
More coral work to discriminate from anthropogenic impacts and natural variability	—	—	—
How can we ID the most vulnerable areas to climate change and be proactive in preparing?	—	—	—
How can we improve enforcement of environmental regulations w/r/t cruiseships?	—	—	—
Small scale connectivity between mangrove, seagrass, and coral reefs for management decisions	—	—	—
Understand environmental conditions that promote coral disease in GOM	—	—	—
Impacts of overfishing effects on coral reefs and other systems	—	—	—

Subject Category: Infauna/Meiofauna

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
Is there a Benthic Index of Biotic Integrity that works in the northern Gulf?	Information on species sensitivity	BOEM, Academic Institutions	Databases with info on fauna and pollutants. Toxicity data?
Benthic Foraminifera (BF) sensitivity as recorders of oil spill events	Large databases of B.F. in different environments. Lab experiments	Academic institutions	BF collections in oil impacted areas
Evaluate the effect of environmental variables versus the effect of pollutants	Long-time series	Academic institutions	Time series databases
How to assess damages without a baseline	Benthic samples in unaffected areas and/or study cores of "pristine times"	Academia, Government	DGOMB
Why do we care about infaunal changes?	Socioeconomic surveys; benthic connectivity to other habitats	NGOs and others	—
Which are the better organisms to evaluate oil impact? More sensitive.	Experiments	Academic institutions related with these topics	Articles, reports
What can bacteria tell us about oil sediment depuration?	Metagenomic and epigenomic of microorganisms from sediments	Academic institutions, CIGOM, CINVESTAV	—
Trophic relationships of fishes that feed on meiofauna	Sampling meiofauna and trophic analysis with isotopic relationship	Academic institutions	—
Concentration of pollutants (PAHs, PCBs, pesticides) in both hosts and parasites	Determining the concentrations of pollutants on both hosts and parasites	Academic institutions; PEMEX; Oil companies	—
What communication of inputs/stresses exist between compartments (benthic, demersal, pelagic) and laterally between regions?	Transport of tracers; concentrations of markers for contaminants	—	—
What are the impacts of the oil platforms (cuttings, debris, sewage) on infauna/meiofauna around them?	Surveys/collections of infauna/meiofauna and sediments	PEMEX and other oil companies; Academic institutions	—

Subject Category: Demersal Fish

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
What is the biodiversity of deep sea fishes in GOM (3600–7200 m)	Deep fish communities - biodiversity, quantity, parasites? Load/prevalance/diversity; Need alternate gear to sample hard bottom	CINVESTAV; UNAM; CICESE	Data for 200-1200m
What is the environmental health of the entire GOM, crossing boundaries?	Connectivity; toxicology; natural toxins & diseases; anthropogenic contaminant loads; nutrients; physical/chemical data	All agencies in MX, US, and Cuba; Universities of the Gulf States	–
What is the period of recovery after oil/natural impact following disturbance (oil, hurricane, etc.)?	Microbial data; Biodiversity across food webs (functional, taxon, genetic); Resilience of organism or community vs ecosystem level; Ecosystem recovery; Clearance rates of pollutants (PAH, PCBs)	Academia, mostly research Universities	National Institute of Petroleum (IMP)
What are the long-term chronic issues affecting coastal zones & ecosystems...pesticides, processed water?	Water quality data databases; Sediment quality; Benthic organisms/changes in biodiversity; Human community health	Universities; Federal Research Agencies	–
Implementation of environmental releases policy and regulation	Policy and regs exist but poorly implemented along the MX coast	–	–
How are fisheries (e.g., tuna, shrimp) activities impacting the biological communities? Top-down pressure?	Long-term monitoring databasess on fish captures; Monitoring is intermittant; Funding for short projects	Data is collected but not shared; INAPESCA; CONAPESCA	–
Improve communication and education of fisheries impacts and issues with fisherman - extension work	Catch data for demersal fishes; Fishery independent data needed	–	–
What solutions to overfishing could be assessed? Mariculture, Aquaculture	Experimental mariculture; Life cycles of fishes; Energy requirements; Nutrition; Aquatic health	CINVESTAV - Mérida; ICML-UNAM; UNAM-SISAL; EPOMEX-USC; INAPESCA	–
Standardization and harmonization of methodology for toxicological studies	“All data” methods across boundaries	CIGOM - All over Mexico	–

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
What is the prevalence, distribution, and risk associated with natural toxins in coastal fisheries (e.g., Ciguatera, Brevetoxins...)?	Cross-boundary collaborations; Food web dynamics; spatial and temporal toxin data impacts and effects; Human health impacts	In Mexico: Monitoring ministry of Health Campeche/Yucatan; Universities; COPRISCAM; CINVESTAV; NAVY is supposed to have surveillance; water sampling	—
What is the effect of marine debris and microplastics on demersal fishes in the GOM?	What are the impacts/effects? Secondary effects/exposure to pollutants; Chemical degradation of plastics; Education/Outreach	UNAM; Need collaborative efforts	—
What are the effects of PPCPs/hormones/pharmaceuticals/cosmetics/illegal drugs, etc. in coastal waters on demersal fish?	Physical, transport processes in GOMx	—	—
How are seasonal fisheries regulations different between countries and how does this affect populations/stocks?	Need international communication; Fisheries in one region may not be protected in another region compared to another, so there may be impacts on stocks/management of species	Dept. of Fisheries & Agriculture; NOAA; USFWS	Zoning/Regs
What are the impacts of invasive species in the GOMx? What are they? Where are they? How are they connected? Impacts on native populations?	Damselfish - oil platform habitat; Lionfish; Tiger shrimp (Penaeus monodon); Phytoplankton-bacteria-pathogens-Vibrio; Sponges; Algae; Enumeration; Ballast water/species movement/diseases that they bring	EADY; CICY-Q. Roo; CINESTAV; ECOSUR; UNAM-ICML	—
What is the connection between coastal and deepwater fisheries - migration, exposure, behavioral effects, bioaccumulation?	—	—	—
What are the “-omics” changes between natural seeps compared to unexposed communities and compared to direct exposure? “Global expression” - metabolomics, proteomics, transcriptomics?	—	—	—
What are the resultant mechanisms employed by fish to deal with chemical exposure?	—	—	—
What are the effects of fisheries gear (e.g., trawls) on seafloor habitat and what can be done? New development of fishing strategies.	Gear selection	PESCA - Federal; NOAA - Federal; SEAGRANT	—

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
Human health impacts of contaminants/toxins in coastal communities and imports/exports?	Identification of natural or anthropogenic contaminants - what are their origins? Repetition/consistency; Sampling, long-term monitoring	Federal (CDC; FDA; EPA) Mexico (Institution of Fisheries); Academic (Tulane; University of Maryland); NIH; SEMARNAT; Cuba (Ministry of Health)	—
What are the drivers of invasive species? Why are they moving to new areas?	Lots of sampling; multidisciplinary sampling; Biogeographical food webs for bigger picture of an ecosystem; Reward-based removal, buy-back incentive	All agencies in MX, US, and Cuba	—
Environmental impacts of mariculture/aquaculture applications	Monitoring; water quality; fish quality/health	—	—



Subject Category: Pelagic Ecology

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
Life stages/population/physical/chemical connectivity across GOM ecosystems	Genetic data; Isotopes; Megafauna tagging/tracking; Mesoscale oceanographic structure	NOAA; Research Centers (e.g. CINVESTAV, UNAM); General literature	Various population studies; Circulation models
Benthic habitat mapping	PEMEX data; remote sensing; direct sampling	NOAA; Research Centers in MX & Cuba	PEMEX data; other oil companies and industry
Cross-national fisheries management (e.g., tuna, shrimp, sharks, snapper, swordfish)	Population structure (space & time); Catch statistics; By-catch statistics; Impacts of pollutants including atmospheric	NOAA; INAPESCA; CINVESTAV; NMFS; CICIMAR-IPN; EPOMEX-USCDM	INAPESCA data; OBIS/GBIF databases; Studies of fish populations; by-catch records
Common science-based regulatory framework for environmental management and response to human impacts	Agency-to-agency information transfer	NOAA; NMFS; USCG; SEMARNAT; ASEA; CNH (Comisión nacional de hidrocarburos); SRE	National regulatory frameworks
Effects of pollutant mixtures on pelagic organisms - Also, nutrient and climate change CO <sub>2</sub> (field and experimental data - bioassays)	Coordinated sampling of water column, sediments and organisms; Coordinate work for experiments	Independent investigators; Academic institutions that already work in this area; ASEA	Scientific papers, reviews, reports
How to compile all the tagging/tracking information that we already have on the pelagic organisms?	More tagging systems and findings; Maps with distributions	—	—
What is the stage of development of the organisms and which area do they cover during each stage?	—	—	—
How does sargassum affect biodiversity and productivity?	—	—	—
What is the role of DOM in nutrient and C-cycling and food web dynamics? Community structure & function across Gulf ecosystems	Pollutants/surveys	NOAA; NMFS; INAPESCA; CONABIO;	—

Proposed Research Question	Necessary New Data?	Entities that Might Collect the Data	Existing Relevant Data in the Inventory
		CINVESTAV; IPN; CICIMAR	
How does physical connectivity compare with biological connectivity?	—	—	—