

NOAA's Integrated Ecosystem Assessment program:

Gulf of Mexico Region 3-Year Work Plan (FY2016-FY2018)

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REGIONAL IEA GOAL/VISION:

The Gulf of Mexico IEA (GoM-IEA) aims to provide socioecological management advice in a manner that is useful under current governance structures while nudging resource managers in the Gulf of Mexico to adopt ecosystem-based management (EBM). Over the next 3-years we aim to continue our interactions with existing management entities using IEA products while expanding our scope to engage and produce products for resource management entities that consider a broader swath of the ecosystem and/or implement place-based ecosystem management. This will allow the GoM-IEA to produce products that merge human dimensions with biophysical knowledge to complete a socio-ecological IEA in the Gulf of Mexico, while continuing to meet the needs of management customers already using IEA products.

INTRODUCTION:

The GoM-IEA has been maturing over the past 5-years. It includes participants from four NOAA line offices. For the past 2-years it has been focusing on developing an IEA for the West Florida Shelf (WFS). It has been successful at getting environmental covariates into stock assessments in the Gulf of Mexico (SEDAR 2013 & 2014), developed an understanding of how climate cycles reorganize the entire ecosystem (Karnauskas et al. 2015), developed a semi-quantitative risk assessment for ecosystem services (Cook et al. 2014), and developed conceptual models and other analyses to implement the IEA with south Florida resource managers (Kelble et al. 2013; Fletcher et al. 2014). GoM-IEA members have developed community social vulnerability indices and human well-being indices for the Gulf of Mexico (Dillard et al. 2013; Jepson et al. 2013).

Not only does the GoM-IEA integrate across NOAA line offices, but it also integrates across disciplines, a notable strength. We plan to take advantage of this integration in this 3-year plan; building upon successes by continuing and expanding our work with the Gulf of Mexico Fisheries Management Council while completing a socioecological IEA on the SouthWest Florida Shelf from Florida Bay through Charlotte Harbor (SWFS) and applying the IEA framework to address a high profile restoration decision concerning Mississippi River diversions in Louisiana. The SWFS IEA will leverage activities being conducted by both a NOAA/COCA project exploring ecosystem services resilience to climate change and the Southwest Florida Resilient Land and Waters Initiative supported by the White House. It will produce products that inform decision-making by state and federal place-based resource management entities. These management entities have already been engaged on ecosystem services and risk assessments through the COCA program and are primed to embrace the IEA framework to improve their decision-making. In addition to the SWFS IEA, we will apply the IEA framework in an integrated socio-ecological manner to investigate the potential impact of freshwater and sediment diversions along the Mississippi River Delta. NMFS/SERO is required to assess the effect of these proposed diversions on NOAA trust resources and has already expressed interest in using the IEA framework to provide the scientific basis. Thus, a fully funded GoM-IEA will produce a

complete IEA to inform NOAA's decision-making on diversions of the Mississippi River, produce a complete socio-ecological IEA for the SWFS, expand work with the GMFMC to include multi-species MSEs for the snapper-Grouper complex on the SWFS, and expand collaborations with our Mexican colleagues on ecosystem assessments in the Gulf of Mexico over the next 3-years.

PRIORITY GOAL #1:

Implement a socioecological IEA on the southwest Florida shelf to inform place based management

We have been working to implement an IEA on the west Florida shelf since 2014. This has resulted in significant scoping of the IEA and IEA-related activities with resource managers from Florida Bay to Charlotte Harbor on the southwest Florida shelf. Moreover, this region is one of four pilot areas for the White House's Resilient Land and Waters Initiative. The scoping activities for IEA-related work has cultivated the relationships necessary to seamlessly implement an IEA and have the products used by resource managers. The resource managers within this study area (Florida Keys National Marine Sanctuary, Everglades National Park, Rookery Bay National Estuarine Research Reserve, Gulf of Mexico Fisheries Management Council, and Florida's Department of Environmental Protection's Aquatic Preserves) are supportive of using the IEA framework to help transfer scientific information to management.

Objective #1: *Select consistent indicators for use throughout this region that assess the full socioecological system and respond to goals of the varying place-based management entities*

Deliverables:

- Identify a comprehensive suite of indicators to assess the socioecological status of the southwest Florida shelf
 - Review current indicators in the GoM Ecosystem Status Report, Community Vulnerability, FKNMS, South Florida Ecosystem Restoration, and Gulf of Mexico Human Well-Being
 - Identify gaps and determine if a suite of pre-existing indicators can address all focal ecosystem components identified in the EBM-DPSER models for this study site

Objective #2: *Produce a southwest Florida shelf ecosystem status report that nests within the Gulf of Mexico Ecosystem Status Report*

Deliverables:

- An ecosystem status report on the status and trends of the comprehensive socioecological suite identified in Objective #1
- Information products (e.g., maps, web visualizations using Gulf Data Atlas) for managers that display the status and trends data in relevant, user-friendly ways

Objective #3: *Quantitatively link ecosystem conditions to ecosystem services and human well-being*

Deliverables:

- Conceptual models linking specific ecosystem conditions, ecosystem services, and human well-being for specific management areas
- Empirical linkages of ecosystem conditions, ecosystem services, and human well-being for specific management areas

- Empirical methods that estimate impacts on ecosystem services and human well-being from altering ecosystem states

Objective #4: *Conduct risk assessments that evaluate the likely future conditions of ecosystem states and services*

Deliverables:

- Initial semi-quantitative risk assessments for ecosystem states and services
- Predicted increase in risk under likely climate change scenarios
- Use results of risk assessments to create scenarios for future ecosystem states that can be used with empirical models (Objective #3)

Objective #5: *Evaluate Management Scenarios that aim to increase the resiliency of the ecosystem, its services, and the well-being of the adjacent human community under likely climate change scenarios*

Deliverables:

- Modify future ecosystem conditions to take into account climate change and develop corresponding scenarios for ecosystem states
- Run models to examine impact of these scenarios on ecosystem services and human well-being
- Evaluate mitigation scenarios to improve the impact of climate change on ecosystem states and services

PRIORITY GOAL #2:

Exchange information between the US and Mexico on current ecosystem assessments in the Gulf of Mexico and work together to develop a strategy for collaboration on research topics identified as high priorities.

The U.S. and Mexico both require an understanding of the current state of science in the Gulf of Mexico, as well as a strategy for engagement on new research projects to inform future management actions. NOAA has been supporting a Binational Project with Mexico, “Integrated Assessment and Management of the Gulf of Mexico Large Marine Ecosystem”, since its inception in 2006. This project aims to set the foundations for Gulf of Mexico-wide (i.e., the Gulf Large Marine Ecosystem, LME) EBM approaches to rehabilitate marine and coastal ecosystems, recover depleted fish stocks, and reduce pollution and nutrient overloading. While the Gulf of Mexico LME project has undertaken important steps towards integrated management, the partnership must continue to fully understand the complexity of ecosystem.

Objective #1: Convene a workshop of U.S. and Mexican scientists to discuss the current state of science throughout the Gulf LME, across a range of disciplines.

Deliverables: Final synthesis report detailing major workshop findings.

Objective #2: *Develop recommendations for future binational research partnerships with relevance to integrated ecosystem assessments.*

Deliverables: A roadmap for recommended bi-national coordination on future ecosystem studies.

PRIORITY GOAL #3:

Continue dialog with Gulf of Mexico Fisheries Management Council and building climate change-ready Harvest Control Rules through the use of Management Strategy Evaluations

We have been working on investigating the efficiency of current harvest control rules, in both a single-species and multi-species framework, and understanding whether they are robust to future predicted changes in climate and variability in natural mortality due to red tide events. The red-tide natural mortality index is already being used in both the gag and red grouper assessments. The GoM-IEA presented to the Gulf of Mexico SSC on single-species management strategy evaluation, and an initial scoping exercise to understand the Council's desired management performance metrics. Further presentations on the topic of multi-species management strategy evaluation are planned for early 2016. Feedback from the Council has been a slow process, and further scoping and opportunities for exchange are needed to advance the process. Additional simulation work will focus on extending the present modeling exercises to inform management questions as requested by the Council, and also on defining "optimal harvest" within the management strategy evaluation framework.

Objective #1: *Continue our dialog with the GMFMC through their advisory body, the Scientific and Statistical Committee (SSC), on management performance measures for the region*

Deliverables:

- Presentations at meetings for the purpose of requesting input and/or development of workshops or meetings specifically designed for this purpose
- Development of a list of measurable management performance measures that will be used to guide management strategy evaluation exercises

Objective #2: *Operationalize red tide index to describe past trends in episodic mortality events, and develop predictive models that guide likelihood of changing frequency of episodic events in the future.*

Deliverables:

- Red tide index for years 1998-present that can be incorporated into single species and ecosystem assessments
- Predictive model or statistical analysis of expected frequency of future red tide events for the West Florida Shelf

Objective #3: *Continue work on single-species and multi-species management strategy evaluation to understand whether current management frameworks for the Florida West Shelf snapper/grouper fishery are sufficiently robust to predicted and unforeseen climate change in that region.*

Deliverables:

- Give three talks to the Standing SSC on single species, multi-species, and ecosystem MSE to increase communication, solidify terminology, and sustain a dialog on management objectives and definitions of "optimal harvest"

Objective #4: *Carry out management strategy evaluation to investigate the implementation of optimal yield for the snapper-grouper complex of the WFS*

Deliverables:

- Coordinate with other activities within the GoM-IEA efforts to create quantitative definition of "optimal harvest"

PRIORITY GOAL #4:

Conduct an IEA to support NMFS decision-making on Mississippi River diversions and develop an adaptive management process to monitor post diversion impacts

The state of Louisiana in conjunction with the US Army Corps of Engineers (USACE) are proposing a number of diversions of Mississippi River water and sediment to stem the catastrophic loss of wetlands in Louisiana. The state of Louisiana has applied to the USACE for a permit for one diversion, termed the Mid-Barataria sediment diversion, under provisions of the Clean Water Act and the Rivers and Harbors Act. Additionally, three other sediment diversions are being evaluated under the auspices of the Louisiana Coastal Area, Mississippi River Hydrodynamic and Delta Management (MRHDM) project, authorized in Congress in the 2007 Water Resources Development Act. While permitting of the mid-Barataria diversion is not imminent, the tentatively selected plan for the MRHDM study (TSP) is proposed to be determined in the spring or summer of 2016 with commencement of engineering and design in the summer of 2016. On October 21, 2015, the Louisiana Coastal Protection and Restoration Authority recommended advancing of the Mid-Barataria sediment diversion near Myrtle Grove and the Mid-Breton sediment diversion at Wills Point toward engineering and design.

The greatest potential impacts to NOAA-trust resources come not from the construction of a diversion, but rather from its operation to deliver water and sediment to estuarine habitats. All proposed diversions are being marketed as requiring and ultimately including a robust adaptive management plan to manage diversion operations to optimize intended outcomes and minimize deleterious impacts to the ecosystem. This provides an excellent opportunity for the NOAA IEA program to pilot the inner parts of the IEA loop by informing the implementation of the adaptive management framework for Mississippi River diversions, and begin exploring how to inform decision-making for environmental compliance in NOAA under the variety of different statutory mandates that apply. Focusing on adaptive management will prepare future IEA activities to integrate with decision making that will continue through the engineering and design, and critically, subsequent operations of Gulf diversion projects.

Objective #1: *Review and evaluate status, utility, and path forward of current biophysical and socio-economic modeling efforts and associated outputs to assess diversion benefits and impacts on important resources. This includes focus on MRHDM models as well as outside of MRHDM.*

Deliverables:

- Review modeling efforts being undertaken by the USACE, CPRA, and The Water Institute for the Gulf assessing impacts associated with diversion projects
- Prepare a recommendation for future modeling needed to better assess diversion impacts or to assist in adaptive management decision-making

Objective #2: *Select indicators from a variety of state and federal sources.*

Deliverables:

- Inventory of current indicators in the GoM Ecosystem Status Report, LA State Master Plan, MRDHM, NEPA, ESA, EFH
- Review of socioeconomic analyses by CPRA, LSU, and Royal Economics
- Proposed suite of integrated indicators needed to assess the efficacy of diversions

Objective #3: *Gap analysis and filling to identify monitoring and/or modeling techniques for indicators identified in Objective #2 (with special emphasis on improving socioeconomic indicators)*

Deliverables:

- Evaluate quality, limitations (e.g., temporal and spatial), and absence of data
- Prioritized list of indicator and predictive capabilities gaps identified in objective #1 and #2

- Employ NCCOS suite of habitat suitability models for 100 estuarine species to fill gaps in predictive capabilities for indicators needed to evaluate proposed diversions. Enhance resolution of models based upon the gap analysis/impact assessment in objective #2
- Employ the NMFS suite of social indicators for coastal communities. Identifying those that may complement the existing indicators and/or modify to adapt to models
- Coordinate and leverage with agencies such as Ocean Conservancy, Gulf of Mexico Alliance, GCOOS and NOAA/USGS who are conducting Gulf-wide synthesis of monitoring programs to fill gaps
- Create a database of discovered information that highlights where we filled gaps with existing information and leveraging of capabilities
- Conduct additional model runs (CASM/EwE, other fish/shellfish models, socio-economic models) beyond MRDM will be conducted where appropriate

Objective #4: *Use ecosystem services approach to understand ecological/economical trade-offs associated with diversion projects.*

Deliverables:

- Empirical linkages from ecosystem state indicators to ecosystem services in the region of the proposed diversion
- Develop trade-off analysis tool that conveys how proposed diversions are likely to affect the production of ecosystem services in the study area and adjacent ecosystems

Objective #5: *Provide useable information to decision-makers for application to decision-making processes associated with diversion engineering & design, construction, operations and adaptive management.*

Deliverables:

- Develop a framework for evaluating diversions and diversion operational plans based on the trade-off analysis tool developed in Objective #4 that predicts both the ecological and socioeconomic impacts of proposed diversion and/or operational and adaptive management plans for diversions
- Develop a list of key considerations which should be considered when deciding how diversions are to be operated
- Provide the scientific basis for monitoring plans that will be used to assess ecological and socioeconomic indicators identified in objectives #1, 2, and 3
- Prepare a decision matrix which lists and prioritizes key considerations into a usable framework to be used for adaptive management. The matrix should be a computerized tool showing how management actions affect (1) various resources individually, (2) achievement of ecosystem objectives in the short term, and (3) achievement of long term ecosystem objectives

Additional Methodological Information:

This proposed work would result in two complete IEA iterations in 3-years. One focused on developing a fully integrated socioecological IEA for the SWFS and one focused on addressing the need to provide robust scientific support for decision-making concerning Mississippi River

diversions. In addition to the two complete IEA iterations, we will deliver MSEs and a revised ESR to the GMFMC to continue to enhance stock assessments in the Gulf of Mexico.

We plan to continue to develop the ideal comprehensive suite of socioecological indicators. This work will help establish a stronger connection and understanding of societies' relationship to the ecosystem. As a means of quantifying the value of ecosystem services to communities, we will incorporate a robust set of well-being and social vulnerability indicators for communities of various scales (e.g., census defined places, census tracts, and counties) along the West Florida shelf in analyses with ecological state indicators. We will utilize fisheries and environmental condition data to establish linkages between social and ecological indicators. This will facilitate an assessment of both the state of the ecosystem and human communities along the coast, while also identifying correlations and potential causal linkages between these subsystems.

Much of the work proposed in this workplan can be easily transferred to other regions as understanding the linkages between human society and ecosystem condition is vital for all IEAs, as is enhancing stock assessments and informing environmental compliance decision-making through the IEA process. Moreover, we will be the first region to inform adaptive management decision-making through the IEA process. This is essential for successful implementation of an IEA; as evidenced by the inner parts of the IEA loop. Using ecosystem services as the bridge between biophysical and human dimensions helps to address the interagency ecosystem services memorandum. Specifically, we expect to be able to transfer our social indicators and the quantitative approaches used to test for linkages between the social and environmental subsystems to other areas of the GoM and ideally, to other IEA regions. Additionally, the GoM-IEA MSE framework and techniques, particularly for building harvest control rules and translating National Standards Guidelines for preventing overfishing into mathematical terms are directly transferrable outcomes.

The GoM-IEA will incorporate a variety of social indicators produced by NMFS and NOS (Jepson and Colburn 2013; Dillard et al. 2013) into the assessment of the ecosystem status and trends, as well as in models to evaluate management scenarios. NMFS scientists will contribute a set of social indicators for coastal communities along the Eastern Seaboard and Gulf of Mexico coast. NOS scientists will contribute a suite of indicators for measuring coastal county well-being and environmental condition along the US Gulf of Mexico. The NCCOS social indicators work seeks to examine the relationship between coastal communities and ecosystems at a broader level, without specifying resources and/or user groups. The NMFS social indicators allow for focus on community-ecosystem relationships specific to fisheries, but have a wider application to other aspects of human well-being and ecosystem models beyond fisheries. As a result, the two methodologies can be used in conjunction to effectively model a variety of the connections between communities and the environment. Other indicators that will be provided by NOS and NMFS include: climate vulnerability, fishing engagement and reliance, and business diversity among the ocean economy sectors. The team will also collaborate closely with regional partners with expertise and ongoing work identifying ecosystem indicators and valuation of ecosystem services (e.g., Harte Research Institute, Nature Serve, NAS Gulf Program).

The GoM-IEA has already been successful at transitioning research into management actions. Most notably, through the use of the red tide mortality index in stock assessments. This included the GMFMC delaying catch setting in 2014 for gag grouper due to unknown red tide mortality effects. This FY16-18 workplan will build upon these successes and enter the GoM-IEA into management arenas with broader mandates to implement EBM. The work with diversions has been specifically requested the NMFS Southeast Regional Office to inform their

decisions on environmental compliance with proposed diversions and to determine if the diversions are being optimally planned and operated. The SWFS socioecological work will utilize a network of place-based resource managers in this area that have already been engaged through a COCA project with some of the same PIs as the GoM-IEA. Thus, these managers are already intimately familiar with some of our IEA products including expert opinion risk analysis and EBM-DPSER models. These tools are used in the COCA project to examine climate change impacts on ecosystem services and the efficacy of potential mitigation strategies.

Additionally, the team will collaborate closely with the Gulf of Mexico Fisheries Management Council to identify indicators that are appropriate for measuring progress toward management objectives. These performance indicators are used within Management Strategy Evaluation frameworks to understand the predicted effects of given management actions on the socioecological system. A number of presentations were recently given the Council's Science and Statistical Committee, which led to a motion to form an ad-hoc working group charged with refining explicit management objectives and performance measures for the Gulf of Mexico. The IEA team will participate directly with this group to develop the appropriate indicators and analyses.

As climate change is a high priority concern for NOAA, especially in the Gulf of Mexico with its low topography, we will incorporate climate change into all priority goals. In priority 1, our MSEs will be conducted to investigate potential mitigation strategies to increase the resiliency of ecosystem services under different climate change scenarios. Additionally, we will include indicators of climate vulnerability in our socioecological model. For priority #3, we will investigate the robustness of harvest control rules under likely climate change scenarios and for priority #4, we will incorporate likely climate change into our MSEs, investigating the effect of diversions on the coastal ecosystem and the services it produces. Lastly, we will work with our federal partners and Mexican colleagues in priority #2 to ensure climate change is being consistently assessed across national borders in the Gulf of Mexico.

To further enhance the utility of IEA products by managers, the southwest Florida shelf ecosystem status report that nests within the Gulf of Mexico Ecosystem Status Report under Priority #1, plans to investigate how to produce additional information products for managers that will display the status and trends data in relevant, user-friendly ways (e.g., maps, web visualizations of time series).

End-Users (e.g. recipients/ beneficiaries of regional IEA work and impact):

The following management entities have already been engaged by the IEA and are likely to use IEA products produced by this 3-year plan:

Everglades National Park, Rookery Bay National Estuarine Research Reserve, Gulf of Mexico Fisheries Management Council, Florida's Department of Environmental Protection's Aquatic Preserves on the SWFS, Gulf States Marine Fisheries Commission, Charlotte Harbor National Estuary Program, Southwest Florida Resilient Land and Waters Initiative being led by the US Fish and Wildlife Service, NMFS Southeast Regional Office, State of Louisiana CPRA, US Army Corps of Engineers.

We plan to engage the following management entities and partners that are likely to benefit from using IEA products:

Gulf of Mexico Alliance, Gulf States Marine Fisheries Commission, Gulf State Coastal Zone Management Programs, other Gulf of Mexico NERRs

Long-term Outcome(s):

This proposal aims to demonstrate how all steps of the IEA cycle, including the inner loop, can support decision-making while including social and ecological components as well as their interaction. The work will also identify and move toward filling research and data gaps, furthering our ability to broaden the GoM-IEA both geographically and in complexity.

Success:

- Illuminating social and ecological trade-offs through the IEA process in a manner that effectively informs management agencies' decision-making.
- Complete two cycles of the IEA loop in two different ecosystems in the Gulf of Mexico; both will inform management decision-making and together they provide the opportunity to compare and contrast complete IEA cycles in a single LME. This will advance a process for using the IEA framework to evaluate future management actions in the Gulf of Mexico LME.
- Increased collaboration with our Mexican colleagues on IEA products and processes
- Provide information products to managers with immediate challenges and needs; following through with the application of this information to provide solid examples of the benefits of the IEA process for adaptive management.
- Increased use of a diversity of IEA products in stock assessments by the GMFMC

Leveraging:

These resources are heavily leveraged with 11 FTEs in the GoM providing support and oversight to the IEA at no cost. This time commitment varies from 1 to 9 months for each person depending on their level of engagement. Priority #1 is leveraging a COCA grant of \$200K per year for the next 2 years. The indicators work is leveraging prior indicator work spanning the ESR, Human well-being, and community vulnerability. Priority #2 will be completed in partnership with BOEM. BOEM has \$250,000.00 dedicated to this effort. Staff time for GoM-IEA team members will be in-kind. Priority #3 is leveraging support of far greater \$60K from a number of places including FATE to accomplish our goals with the GMFMC. Priority #4 Gulf of Mexico Regional Coordination team is funding socioeconomics of diversions workshops.

COMMUNICATION AND OUTREACH

The program disseminates information to partners and stakeholders through:

- Presentations and ongoing engagement at workshops and meetings (e.g. fisheries management council, advisory groups)
- Reports including ESRs
- Data available via web tools and applications
- Models and other management tools (e.g. conceptual models, risk assessments)
- Peer-reviewed publications

The program uses feedback from partners and stakeholders to:

- Identify the greatest management issues for which IEA is needed
- Shape the management and climate scenarios for which MSEs are conducted
- Conduct effective gap analyses
- Formulate relevant results and products for managers
- Refine existing products and efforts to ensure they are tailored to the appropriate audiences

APPENDIX A: PAST ACCOMPLISHMENTS/ PROGRESS

As mentioned above the GoM-IEA has been leading the way in attempting to integrate Human dimensions and biophysical components in the IEA. We have developed a modified conceptual modeling framework that incorporates ecosystem services as the natural bridge among these disciplines. We have also developed indicators for the ecosystem state, human communities, and human well-being. In this plan, we are taking the next logical step of working to integrate these indicators into a single ESR and to complete the full IEA loop with both components being integrated throughout. To be prepared for this plan, we have developed ecosystem services based risk assessments, and begun looking at methods to empirically link Human Well-Being to ecological indicators, which is necessary for doing integrated MSEs.

Social data was collected and analyzed for the SWFS focus area and broader GoM region to assess coastal counties using well-being indicators. The NOS/NCCOS team began exploration of methods for analyses of links between ecosystem state and human well-being for West Florida and drafted conceptual models linking ecosystem services to human well-being. Through collaboration between NCCOS and NCEI, social data for the Gulf of Mexico went live on NOAA's Gulf Data Atlas (gulfatlas.noaa.gov) in FY15. The Gulf of Mexico Coastal Community Well-being Data includes social indicators for the coastal states of Florida, Alabama, Mississippi, Louisiana, and Texas at five time points spanning 2000-2012. The team also developed a query driven database for these social indicators at NOS/NCCOS.

The creation of the first Ecosystem Status Report for the Gulf of Mexico has allowed for synthesis of a wide range of indicators on the state of the physical, biological and socioeconomic components of the ecosystem. The report provides a basis for ongoing understanding of change in the ecosystem as a whole (e.g., Karnauskas et al. 2015), and for further refining indicator development in our region. Near-term updates of the Report will incorporate the suite of socio-economic indicators to be developed as described above.

The Gulf of Mexico Ecosystem status report has indirectly informed both strategic and tactical management decisions in the Gulf of Mexico. The suite of indicators within the report have been used in synthesis analyses by both the IEA team itself and other management bodies such as the Ocean Conservancy. Specific indicators from the Report have spurred thinking on how the environment may play a role in single-species dynamics (e.g., sea surface temperatures and swordfish migrations; the role of the Loop Current in driving recruitment strength of groupers and snappers). Environmental indicators have been incorporated into multiple stock assessments.

The GoM IEA program has successfully worked to improve stock assessments by getting the red tide mortality index incorporated into both Gag and Red Grouper assessments. Moreover, the GoM-IEA developed both single-species and multi-species management strategy evaluations for the purpose of informing management of the snapper-grouper complex on the West Florida Shelf. Presentation of these analyses to the Gulf of Mexico Fisheries Management Council has resulted in a dialogue between scientists and managers and ongoing improvements to this work.

APPENDIX B: PRIORITY GOAL WORKPLANS

Priority Goal #1 Workplan

Deliverable (from above)	Task/Activity	Expected Date	Responsible LO/ Partner (or Person)
Socioecological Conceptual Models	Review existing models and literature to develop a socioecological conceptual model	April 2016	OAR/AOML (Chris Kelble), NMFS/SEFSC (Mandy Karnauskas) & NOS/HML (Maria Dillard)
Socioecological Indicator Suite	Collate existing indicators and conduct Gap Analysis	June 2016	OAR/AOML (Chris Kelble) & NOS/HML (Maria Dillard)
Socioecological ESR	Ecosystem Status report on the status and trends of socioecological indicators	December 2016	OAR/AOML (Chris Kelble), NMFS/SEFSC (Mandy Karnauskas), NMFS/SERO (Jepson) & NOS/HML (Maria Dillard)
Information Products for Socioecological ESR	Develop information products to use socioecological ESR to inform resource management	June 2017	NOS/HML (Maria Dillard), NESDIS (Scott Cross), OAR/AOML (Chris Kelble)
Empirical linkages between ecosystem states, services, and human well-being	Statistical analyses to empirically investigate and quantify these connections	June 2017	NOS/HML (Maria Dillard), NMFS/SERO (Jepson), OAR/AOML (Kelble)
Semi-Quantitative Risk Assessments	Risk assessments on ecosystem states and services under current and projected future conditions	December 2017	NOAA/AOML (Kelble)
Evaluate Climate Scenarios	Predict climate scenario effects on ecosystem states, services, and human well-being	December 2017	NOAA/AOML (Kelble), NOS/HML (Dillard), NMFS/SEFSC (Karnauskas)
Evaluate Management Scenarios	Predict how management actions will interact with climate scenarios to affect ecosystem states, services, and human well-being	June 2018	NOAA/AOML (Kelble), NOS/HML (Dillard), NMFS/SEFSC (Karnauskas)

Priority Goal #2 Workplan

Deliverable (from above)	Key Tasks/Activity	Expected Completion Date	Responsible LO/ Partner (or Person)
Workshop synthesis report	Identify participants, design and convene workshop	September 2016	NOS/OCM (Allee), NOAA/AOML (Kelble), NMFS/SEFSC (?)
Roadmap of bi-nationally coordinated ecosystem studies	Develop recommendations based on workshop findings	September 2016	NOS/OCM (Allee), NOAA/AOML (Kelble), NMFS/SEFSC (?)

Priority Goal #3 Workplan

Deliverable (from above)	Key Tasks/Activity	Expected Completion Date	Responsible LO/ Partner (or Person)
Presentations to the GMFMC and SSC (at least three)	Maintain an ongoing dialogue on MSE and EBFM	Sept. 2016	NMFS(Schirripa, Karnauskas, Harford, Gruss); USF (Ainsworth)
Propose the creation of and participate in “scientists and managers dialogue” ad-hoc working group	Identify key management performance measures for MSEs	Sept. 2016	NMFS(Schirripa, Karnauskas, Harford, Gruss); USF (Ainsworth)
Red tide Index	Operationalize the existing red tide index and evaluate capability for red tide predictions	Sept. 2016	NMFS(Walter, Sagarese, Harford)
Continue work on single and multi-species MSE for Florida West Shelf	White paper publications on MSE procedures and outcomes	Sept. 2016	NMFS(Schirripa, Karnauskas, Harford, Gruss); USF (Ainsworth)

Priority Goal #4 Workplan

Deliverable (from above)	Key Tasks/Activity	Expected Completion Date	Responsible LO/ Partner
Model Evaluations	Evaluate the present status of MRHDM models; evaluate assumptions/output and adpt. mgmt. evolution of models or alternatives	Present status of modeling and output evaluation – Year 1; Operations/Adaptive Mgmt. – Years 2-3.	AOML, NCCOS, & SERO
Ecosystem Indicators	Inventory current indicators and select those appropriate for use; ID gaps	Year 1	AOML, NCCOS, & SERO
Monitoring and Modeling Gap Analysis Report	ID data gaps to inform tools and impacts; ID data acquisition & monitoring needs	Year 2	SERO
Gap Filling	Data acquisition (existing); modeling	Years 2 and 3	SERO
Ecosystem Services Analysis	Dedicated model runs; MSE; collaborate with complementary Gulf indicator efforts	Years 2 - 3	AOML & SERO
Decision-Support Tools and Products	Trade-off analysis/Decision matrix	Year 3	AOML & SERO

APPENDIX C: REFERENCES

- Cook, Geoffrey S., Pamela J. Fletcher, and Christopher R. Kelble. 2014. Towards marine ecosystem based management in South Florida: Investigating the connections among ecosystem pressures, states, and services in a complex coastal system. *Ecological Indicators* 44. Elsevier Ltd: 26–39. doi:10.1016/j.ecolind.2013.10.026.
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