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Expiration Date 12/31/2019

Annual Progress Report

A. Grant Number: NA16NOS4780202

B. Amount of Grant: $900,000

C. Project Title: NGOMEX 2016: User-Driven tools to predict and assess effects of reduced nutrients and hypoxia on living resources in the Gulf of Mexico

D. Grantee Organization: George Mason University

E. Award Period: From: 09/01/2016 To: 08/31/2020

F. Period Covered by this Report: From 06/01/2017 To: 05/31/2018

G. Summary of Progress and Expenditures to Date:

1. Work Accomplishments: (as related to project objectives and schedule for completion)

   a. Provide a brief summary of progress, including results obtained to date, and their relationship to the general goals of the grant

Overall Progress and Status:

An expansive hypoxic zone in the Northern Gulf of Mexico (NGOMEX) will affect ecologically and economically important living resources, but the magnitude, predictability and even the direction of these changes remain elusive. Managers and stakeholders alike need readily available and quantitative tools to assess the effects on living resources of planned nutrient reduction strategies aimed to minimize the hypoxic zone. Our proposed program couples spatially-explicit ecosystem, bioenergetics, and water quality models to evaluate alternative management strategies, interannual differences in water flows, nutrient loading and water temperatures, and longer-term climate changes on living resources.

Our work thus far and our plan for the future both focus on the development of user friendly, management-scale relevant forecasting tools and our project is on target as originally proposed. We have made substantial progress towards our goals this year. It has also been a very productive year, with 4 manuscripts accepted for publication, 3 manuscripts in review, progress on drafts of 4 manuscripts, 9 papers given or accepted for presentation, 4 special sessions or symposia at major scientific conferences, and a management committee workshop held during the Fisheries Monitoring Workgroup Meeting.

<u>Bioenergetics Models:</u> We proposed that we would improve species bioenergetics, food web, and spatially/temporally explicit modeling capabilities of key living resources in the NGOMEX in response to changing hypoxic and climatic conditions. We have made substantial progress towards completion of this goal over the past year. We now have five bioenergetics models ready to be applied to simulations. We have developed a bioenergetics-based growth rate potential model for brown shrimp (*Farfantepenaeus aztecus*). We have also refined bioenergetics-based growth rate potential models for red snapper (*Lutjanus campechanus*), Atlantic croaker (*Micropogonias undulatus*), and Gulf menhaden (*Brevoortia patronus*) (Figure 1). We prepared a previously developed bioenergetics model for bay anchovy (*Anchoa mitchelli*) to be used in simulations by coding the model in R statistical language. These models have been developed and revised in collaboration with Kenny Rose's lab to ensure the results of our research can be compared. Finally, we scoped out a bioenergetics model for Atlantic bumper and were unable to locate enough basic information on bumper metabolism to create a full bioenergetics model.

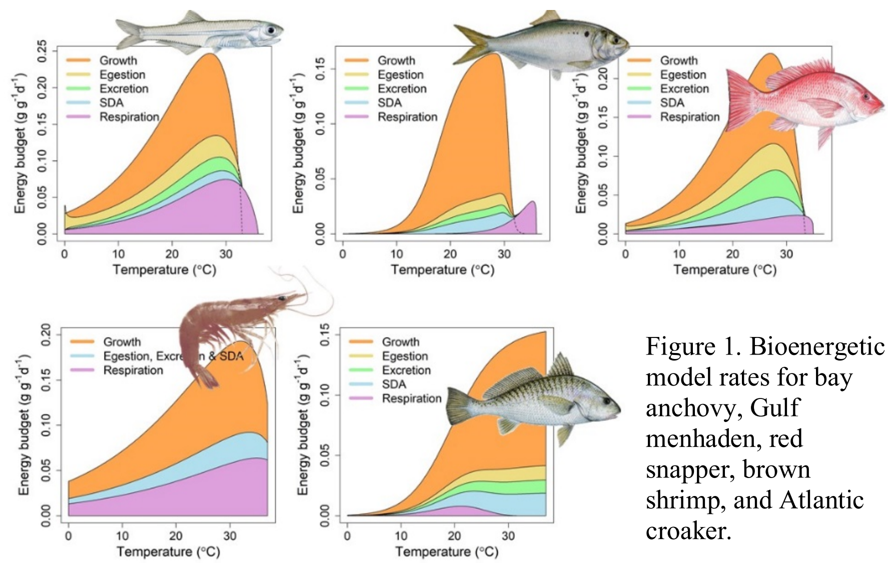

Figure 1. Bioenergetic model rates for bay anchovy, Gulf menhaden, red snapper, brown shrimp, and Atlantic croaker.

<u>Connecting Nutrient Loading to Fish Habitat Quality:</u> We proposed that we would determine effects of nutrient loading and hypoxic volume reduction scenarios on growth rate potential, habitat quantity and quality, and fish population size. We have made substantial progress toward this goal in the past year. We examined the effects of nutrient loading and hypoxic volume reduction scenarios on growth rate potential, habitat quantity and quality and made direct linkages of Fish Habitat models to 3-D water quality model output under various nutrient loading scenarios. Code was developed in Matlab and R to run GRP models on ROMS model output. Additional code was developed to produce time series and maps of GRP for each depth layer. This year we specifically focused on completing the ROMS-to-GRP linkage for Gulf menhaden and bay anchovy. The GRP model for both species was run on over 160,000 cells on a daily basis over 12 years in the 3D hydrodynamic/water quality model for the following scenarios: 60N/60P, 80N/80P, and 100N/100P. Phytoplankton and zooplankton output from the ROMS model were used as the prey source for the menhaden and anchovy GRP models, respectively. The procedure is mostly automated, described by a detailed workflow, and can be customized and replicated for additional scenarios and species.

Habitat quality for menhaden in this model does not appear to be impacted by prey (phytoplankton) density (Figure 2). Menhaden GRP increased in areas where hypoxia decreased (Figure 1). There were few changes in menhaden GRP with a 20% reduction in nutrients, but a larger difference in menhaden GRP with a 40% reduction in nutrients, indicating that fish response to nutrient reduction is unlikely to be linear.

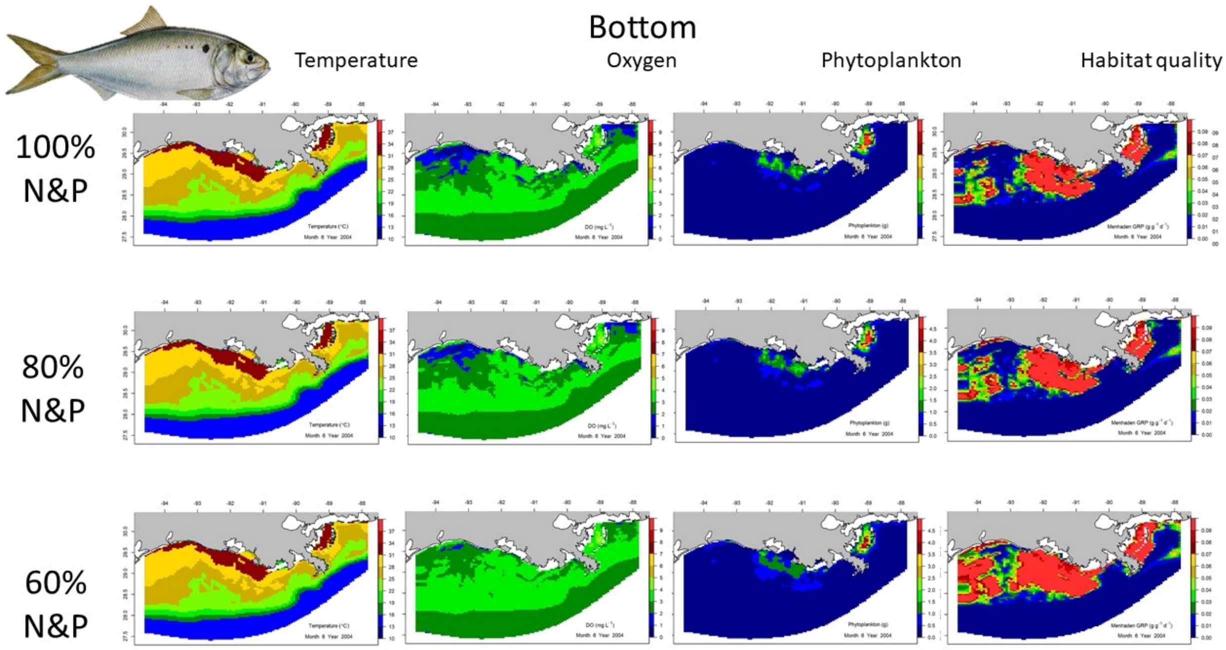

Figure 2. Maps of temperature, oxygen, phytoplankton, and GRP for menhaden at the bottom of the water column in June 2014 under scenarios of 100% N&P, 80% N&P, and 60% N&P.

In our models, a reduction in nutrients means lower habitat quality for anchovy, because lower nutrients means less zooplankton (Figure 3). Anchovy habitat quality is rarely impacted by hypoxia in these models because GRP is low in the summer, largely due to high temperatures and low zooplankton concentration (Figure 3).

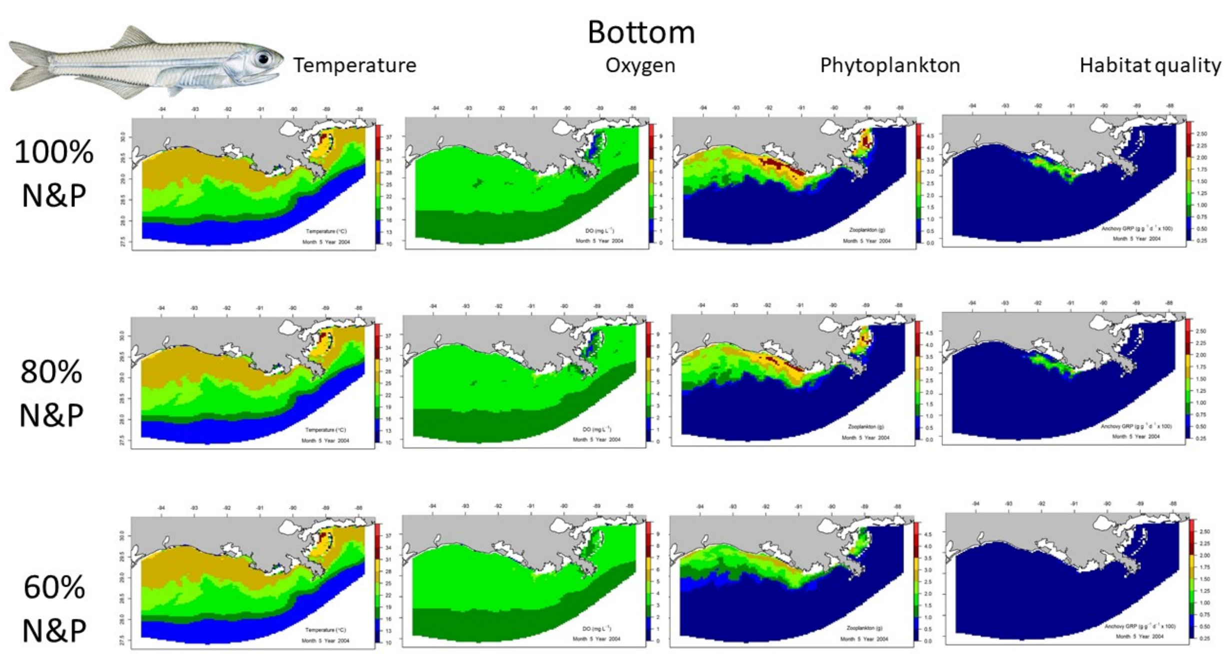

Figure 3. Maps of temperature, oxygen, phytoplankton, and GRP for anchovy at the bottom of the water column in June 2014 under scenarios of 100% N&P, 80% N&P, and 60% N&P.

Time series of hypoxic volume show little reduction in hypoxia when nutrients are reduced (Figure 4). This is likely because our model domain extends well beyond the shallow waters where hypoxia occurs. If the model domain were restricted to shallow waters, the time series would show a reduction in hypoxic volume when nutrients are reduced.

Nutrient reduction results in a lower (and less variable) proportion of the water column with phytoplankton biomass densities > 2 g m^{-3} (Figure 4). This reduction in lower trophic level biomass occurs in the spring and summer. Similar trends are evident in zooplankton biomass (not shown). A 40% reduction in nutrients made a much larger impact on phytoplankton biomass than a 20% reduction in nutrients, indicating the lower trophic level response to nutrient reduction is nonlinear.

Menhaden GRP increased with nutrient reduction in the summer months due to reduction in hypoxic volume near shore (Figure 4). However, a decline in menhaden habitat quality was observed every year in late summer. These declines were attributed mainly to high temperatures and in part to hypoxic volume.

Anchovy GRP declined with nutrient reduction (Figure 4). These declines were attributed to declines in zooplankton biomass. Similar to trends in phytoplankton biomass, a 40% reduction in nutrients made a much larger impact on anchovy GRP than a 20% reduction in nutrients, indicating a nonlinear response to nutrient reduction.

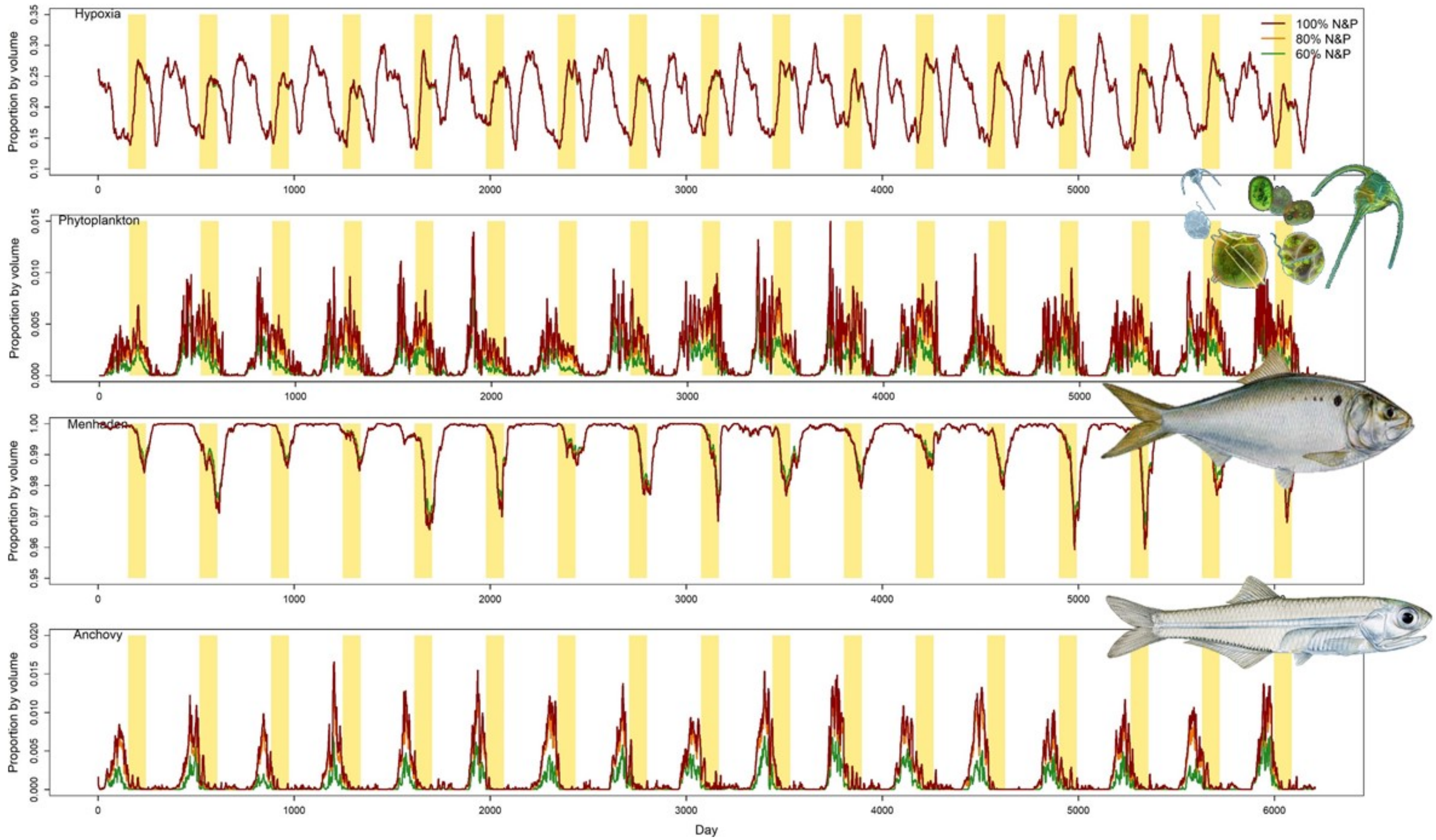

Figure 4. Time series from beginning of 2000 to end of 2016. Proportion of the water column by volume of hypoxic water (dissolved oxygen < 2 mg L^{-1}), phytoplankton (> 2 g m^{-3}), menhaden GRP (> 0 g g^{-1} d^{-1}) and anchovy GRP (> 0 g g^{-1} d^{-1}). Yellow shading are summers (June-August).

Interannual Fish Habitat Quality: We have made substantial progress towards our goal of reconstructing water column fish habitat quality for each of the key species using field data (temperature, oxygen, and chlorophyll) from research cruises conducted between 2003 and 2010. We analyzed historic field data from research cruises (2003, 2004, 2006, 2007, 2008, 2009 & 2010) to identify fish habitat quantity and quality in the Gulf of Mexico. We plotted dissolved oxygen, water temperature and chlorophyll data for the entire seven years of data and for depths ranging from 0 – 29 meters at one meter intervals. All transects were processed to remove noise caused by non-biological sources (e.g., surface turbulence caused by waves or ship wakes, methane gas bubbles, bottom return effects). We extracted ROMS model output along each transect to validate model results with real field conditions.

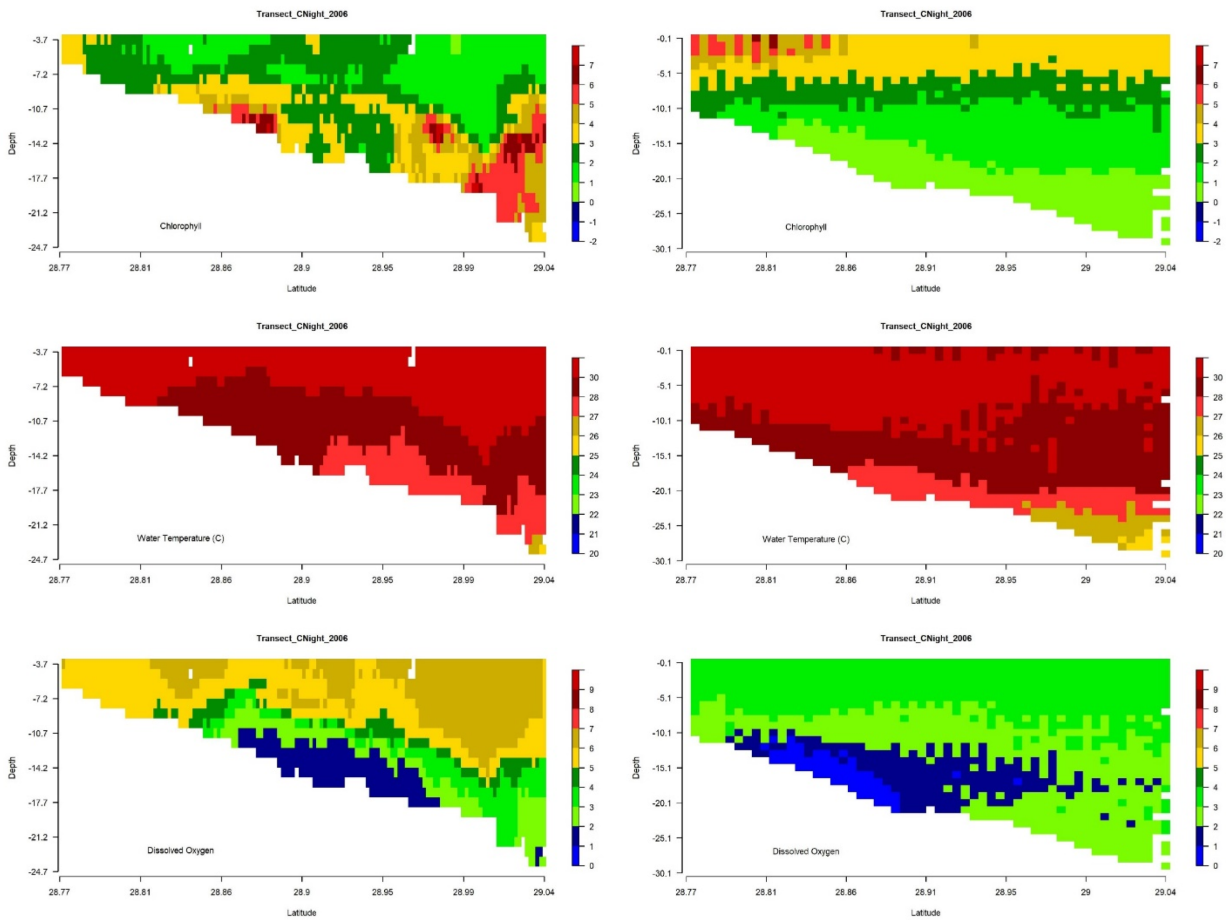

Figure 5. Transects of chlorophyll (top), temperature (mid) and dissolved oxygen (bottom) from field transects (left) and ROMS model output (right).

Transect temperature and dissolved oxygen closely matched model results (Figure 5). The ROMS model was able to replicate stratification in temperature and bottom hypoxia during the summer months. However, the ROMS model's chlorophyll output did not match observed spatial trends in chlorophyll. In the field, a midwater chlorophyll maximum is often observed just outside the hypoxic zone (Figure 5). The ROMS model did not reproduce this midwater chlorophyll maximum, but instead confined high chlorophyll production to surface waters. Thus, this project has identified increased capability to predict water column chlorophyll as a **minimum data need for forecasts of nutrient reduction in the NGOMEX.**

Ecopath model improvements

The NGOMEX Ecopath model was updated to represent 2000. For this all start biomasses were recalculated as the mean biomass from 2000-2005 based on SEAMAP data. In the case of brown shrimp, white shrimp, gulf menhaden, blue crab and red snapper, biomass was based on stock assessment. Diet data were updated using the cruise data collected by Roman and Brandt in our previous NGOMEX project, the GoMexSi diet dataset, and new literature since the previous version of the model was developed (literature since 2012). Gulf Butterfish was added which was one of the recommendations that came out of the first workshop (juveniles and adults). Multiple multi-stanza groups were created for Gulf Menhaden to match the life stages in stock assessment. Fisheries information (fleets and landings) was updated. The new Ecopath model was rebalanced after these changes (Figure 6).

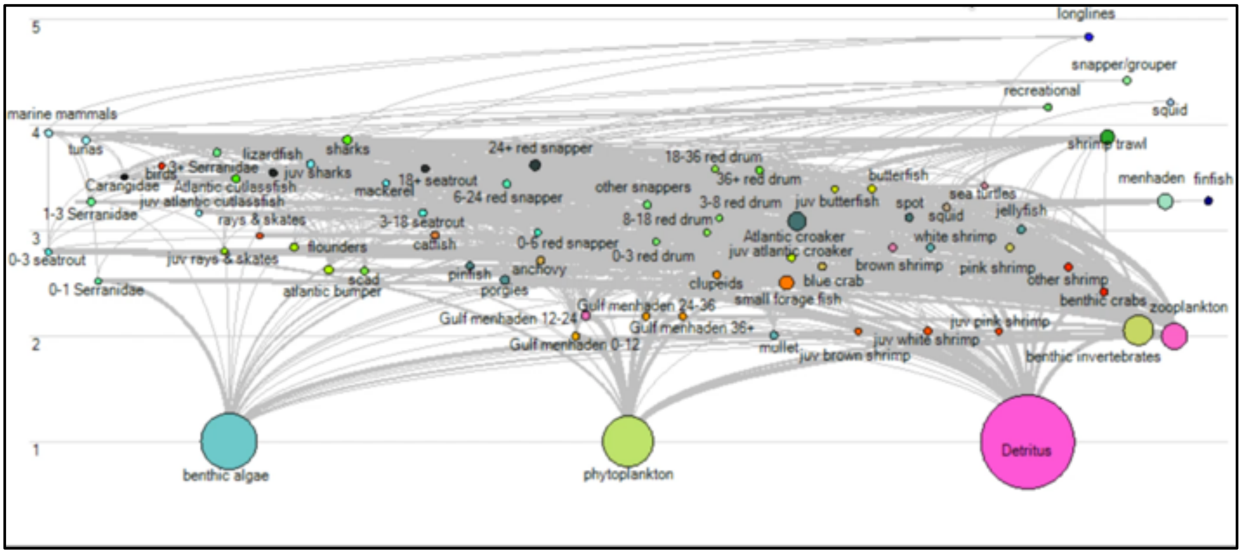

Figure 6. Trophic diagram of the new NGOMEX Ecopath model. The y-axis represents trophic level, the size of the dots the relative size of the biomass pool, the connectors represent predator-prey interactions or in case of the fleets (upper right corner) the connection to the species a particular fleet removes (including bycatch).

Ecosim calibration

The new model was recalibrated in Ecosim, using annual fisheries independent observations (SEAMAP data) to calibrate biomass, and fisheries landings to calibrate catch. In the case of brown shrimp, white shrimp, gulf menhaden, blue crab and red snapper, information from stock assessment reports was used to calibrate the biomass and catch. Ecosim is time-dynamic only, so observations were averaged to get one value for the model area. The same was done for the drivers (ROMS output) which included Chl *a* and dissolved oxygen. Using AIC was determined that adding salinity and temperature did not improve the model for calibration, although they will be added in the spatial model. This was to be expected as the average salinity and temperature may not explain much of the variation, while they may provide important contributions to species distribution once in Ecospace and one value per grid cell (per month) is included in each simulation. The model was fitted to biomass (Figure 7) and landings data (Figure 8) with the vulnerability exchange rate as the variable parameter. The best-fit model was determined using AIC and sum of squares deviation.

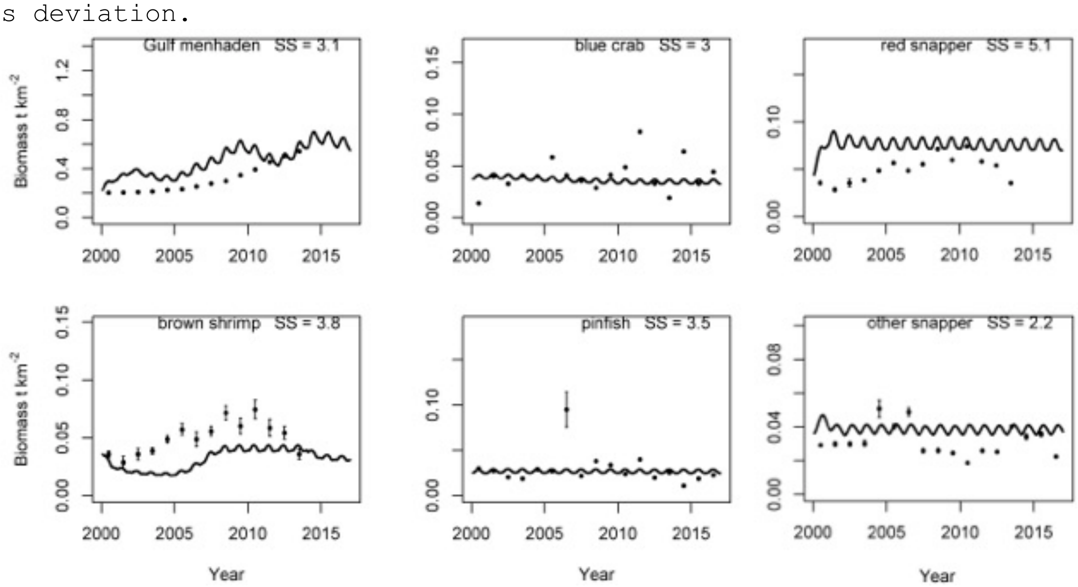

Figure 7. Select biomass calibration plots. The dots are observations, while the lines represent simulated biomass in the model. SS is the sum of squares and indicates model fit. Error bars represent 95% confidence intervals.

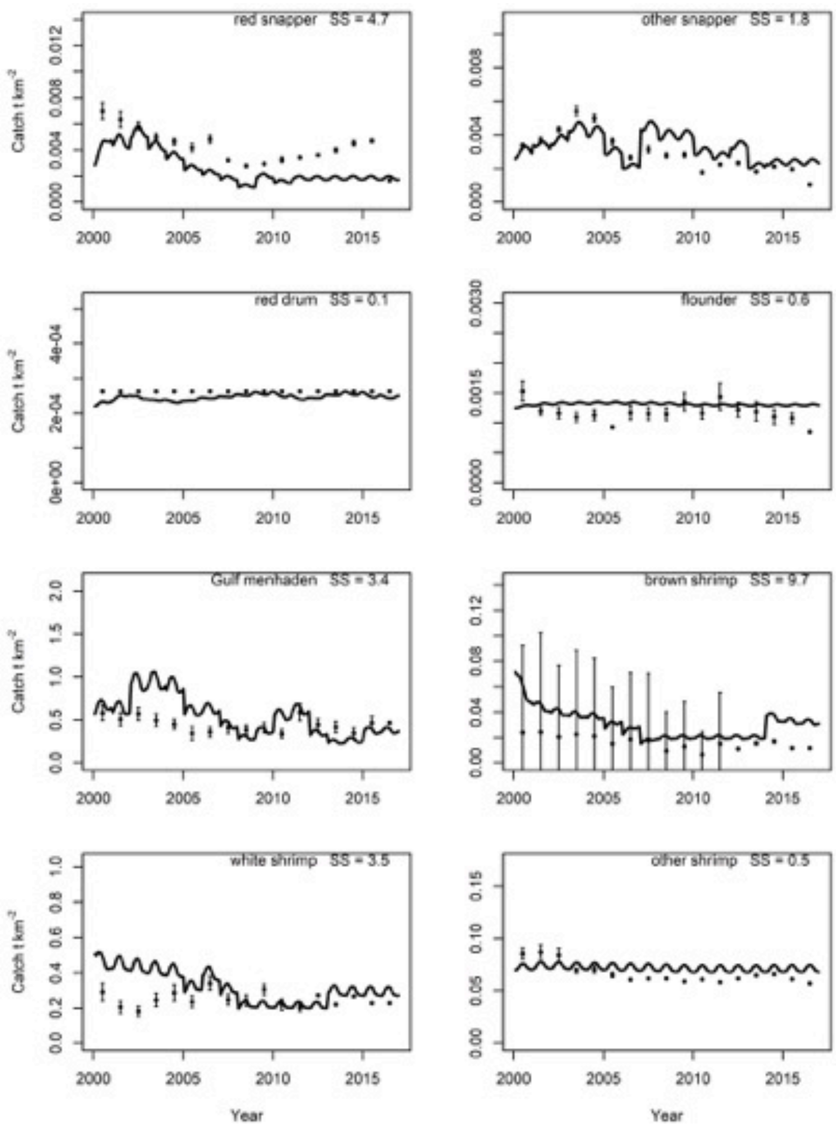

Figure 8. Select catch calibration plots. The dots are annuals landings data, while the lines represent simulated catch in the model. SS is the sum of squares and indicates model fit. Error bars represent 95% confidence intervals.

Ecospace development and simulations:

The spatial-temporal framework as described in Steenbeek et al. (2013) is incorporated in the model framework, which was not the case with the previous version of the model. While a custom plug-in allowed for spatial and temporal variation of dissolved oxygen and Chl *a* specifically, this was a limited (to those two parameters) spreadsheet-based approach. The spatial-temporal framework is GIS-based and allows for inclusion of an unlimited amount of map layers representing the condition in each cell based on environmental parameters and/or habitat attributes. In a spatial simulation scenario, the value of each cell is updated with each monthly time step (i.e. a new map is read in per parameter at the start of each time step). Examples of driver maps are shown in Figure 9 and 10. The groups in the model respond to these drivers as prescribed by species-specific response curves. As part of the spatial-temporal framework, these response curves are loaded as graphs, and can take any shape. This is an upgrade from the previous model as well, where response curves were loaded in a spreadsheet as optimum and standard deviation with either a binomial or sigmoidal shape. Because of this, all new response curves were created for dissolved oxygen, temperature, and salinity based on SEAMAP data where fish and environmental parameters were collected simultaneously.

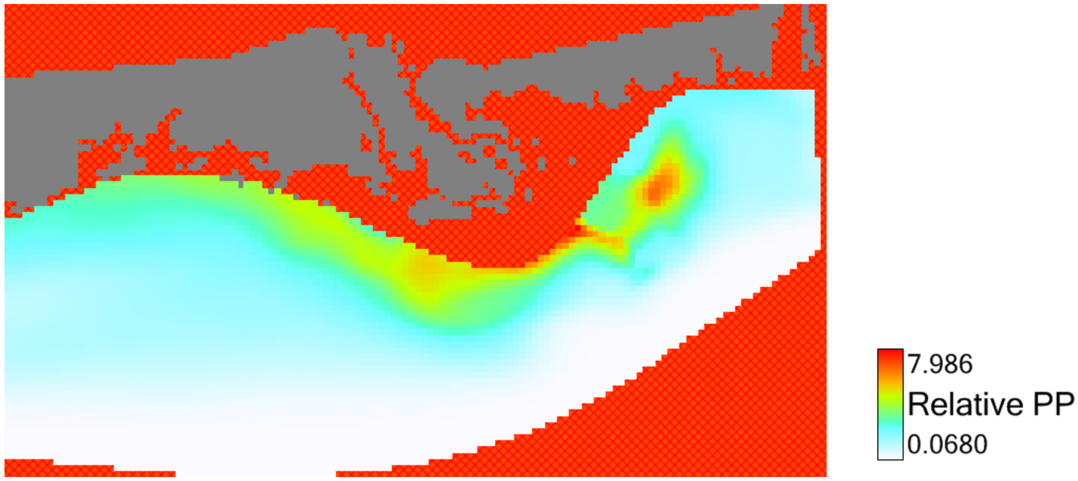

Figure 9. Example map of relative primary productivity based on ROMS Chl a output. This map represents January 2000. The red crossed-out area is an exclusion layer, and ensures only cells that receive ROMS data as drivers are active.

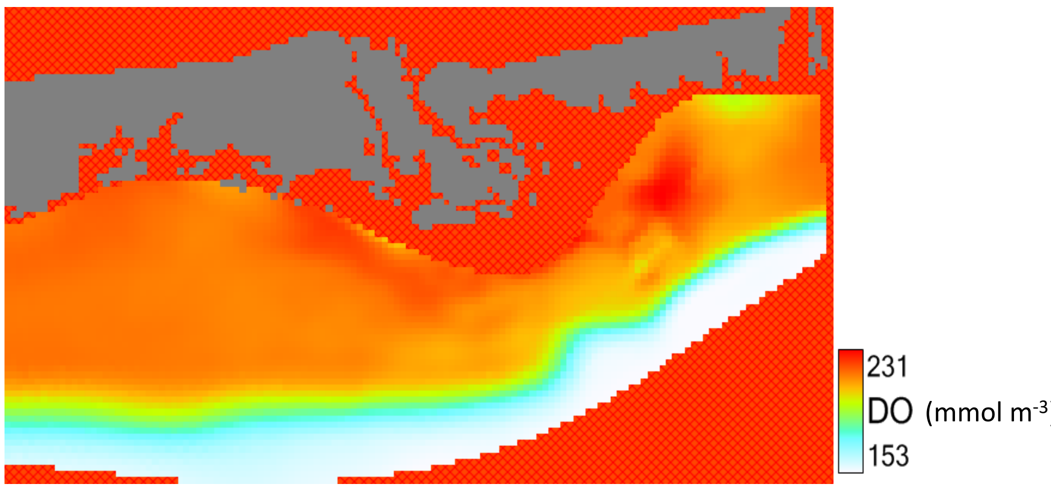

Figure 10. Example map of bottom dissolved oxygen based on ROMS Chl a output. This map represents January 2000. The red crossed-out area is an exclusion layer, and ensures only cells that receive ROMS data as drivers are active.

The first nutrient/hypoxia scenarios that were simulated with the new Ecospace model were 100% N&P, which is output from the calibrated ROMS model from 2000-2016, and 60% N&P, which represents a scenario with 40% nitrogen and phosphorus reduction. To represent what changes the reduction may entail, the difference between the two scenarios was taken, to represent the effects of the nutrient reductions versus a future without action. Preliminary results of the effects on biomass of select living marine resources are shown in Figure 11.

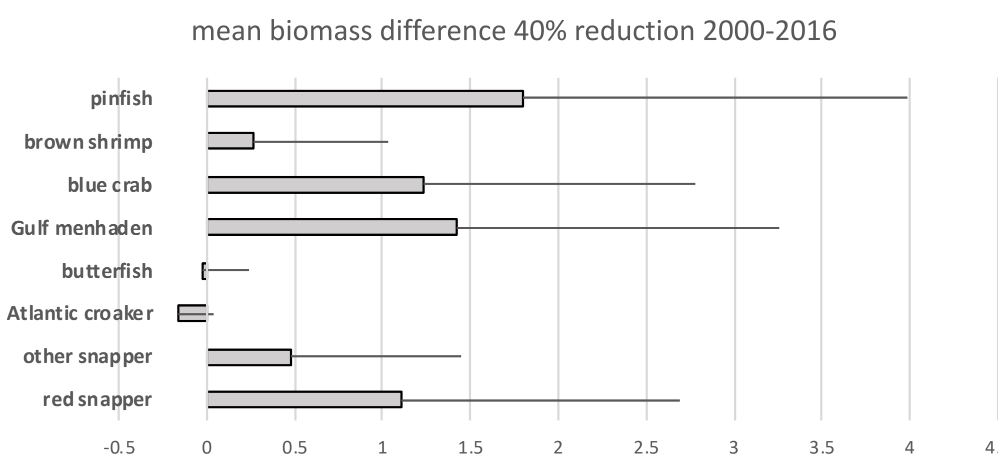

Figure 11. Average percent change in biomass of select species in the NGOMEX Ecospace model of the 60% N&P scenario as compared to a future without action (100 % N&P) over a 17-year model run (2000-2016). Error bars are 95% CIs.

Preliminary results of this nutrient reduction scenario suggest that effects on biomass or mostly small and positive. Detailed analysis of model results is scheduled in the next period to determine the mechanisms behind the results, and whether these changes can be confirmed as best estimates, or whether more adjustments to the models and the model coupling mechanism needs to occur.

<u>**Connections to Management Needs:**</u> **The ultimate goal of this research is to develop management tools in collaboration with fisheries managers that can be readily applied to test alternative management strategies to reduce hypoxic volume, and investigate subsequent effects on fish growth, population dynamics (e.g. abundance and biomass), and fisheries catches. In year 1 of this project, we received valuable feedback from the workshop at GOMOSES. In year 2, we are incorporating this feedback into our approach.** Products identified as desirable by attendees were habitat quality maps and a way to interface GRP modeling with observing systems. In addition, the bioenergetics models themselves were of interest to managers. Due to these end-user priorities, **we continue to develop and refine an open source version of the GRP model that can be freely shared with fisheries managers and adapted to interface with a variety of observing systems**. These models are now mostly automated, described by a detailed workflow, and can be customized and replicated for additional scenarios and species. We intend for these models to be used directly by conference participants and their colleagues. We also anticipate the R platform will allow us the flexibility to apply this modeling framework to existing observing systems.

In year 1 we identified opportunities for collaboration with Kenny Rose (UMCES), who is also completing a project funded under NGOMEX. We have collaborated with the Rose lab to produce Atlantic croaker, Gulf menhaden, red snapper, and brown shrimp bioenergetic models. We anticipate comparing and contrasting our results to validate and assess if different approaches produce similar conclusions. This will strengthen products from both research programs.

During the 2018 Fisheries Monitoring Workgroup Workshop in Stennis, MS, the NGOMEX project PIs (de Mutsert, Brandt, Rose, Justic, Obenour, Craig) met with members of the management committees to discuss progress and ensure research is informed by management guidance. The project PIs agreed to run one nutrient scenario in common to allow the results of the projects to be compared.

b Provide a brief summary of work to be performed during the next year of support, if changed from the original proposal; and indication of any current problems or unusual developments that may lead to deviation of research directions or delay of progress toward achieving project objectives.

In the next year of funding, we will continue to improve species bioenergetics, food web, and spatially/temporally explicit modeling capabilities of key living resources in the NGOMEX in response to changing hypoxic and climatic conditions. GRP models focusing on some of the key ecologically and economically important species of the region will be further refined for this project. We also plan to develop models for spotted seatrout and red drum according to suggestions from workshop participants.

We will continue to make progress examining the effects of nutrient loading and hypoxic volume reduction scenarios on growth rate potential, habitat quantity and quality and make direct linkages of Fish Habitat models to Ecopath with Ecosim (EwE) models. We will run the GRP model on additional nutrient reduction scenarios as determined by the management committee at the Fisheries Monitoring Workgroup Workshop.

We will reconstruct the inter-annual fish habitat quality for each of the key species using the historical temperature and oxygen data we have compiled from NOAA's World Ocean Data Base. Annual indices will be compared to ROMS model output, historical catches, and monitoring information of fish sizes (from SEAMAP). This information will allow us to validate modeled output through time.

Multiple nutrient reduction scenarios will be simulated in Ecospace. Available nutrient reduction scenarios were presented in last year’s report.

After the Fisheries Monitoring Workshop, we agreed upon looking into the option to obtain results from the ROMS model of a 45% N&P reduction. This is now indeed planned for the next reporting period. We will also use the GRPs of those species for which they are created, and convert them to habitat capacity layers in Ecospace instead of deriving them from environmental drivers and response curves.

The second workshop will take place during the next year of support, and is tentatively planned for July 2019 in Miami. We aim to have decision support tools ready to be tested during the workshop. We aim to hold this in Miami to facilitate participation of NOAA's Integrated Ecosystem Assessment group at the Southeast Fisheries Science Center.

2. Applications:

This section should describe specifically the outputs and management outcomes achieved. Outputs are defined as products (e.g. publications, models) or activities that lead to outcomes (changes in user knowledge or action). In cases where proposed management outcomes are not fully achieved, indicate the progress made during the reporting period. Also, indicate expected outputs and management outcomes for the next year of support.

a. Outputs

i. New fundamental or applied knowledge
ii. Scientific publications

(note: As stated in our proposal some of our tools are being refined and tested in the North Pacific and Great Lakes)

Manuscripts published

De Mutsert, K., Lewis, K.A., Milroy, S., Buszowski, J., and J. Steenbeek. 2017. Using ecosystem modeling to evaluate trade-offs in coastal management: effects of large-scale river diversions on fish and fisheries. Ecological Modelling 360:14-26.

Glaspie, C. N., Clouse, M., Adamack, A. T., Cha, Y., Ludsin, S. A., Mason, D. M., Roman, M. R., Stow, C. A., and Brandt, S. B. 2018. Effect of hypoxia on diet of Atlantic bumper Chloroscombrus chrysurus in the northern Gulf of Mexico. Transactions of the American Fisheries Society. DOI: 10.1002/tafs.10063.

Goto, D., Roberts, J. J., Pothoven, S.A., Ludsin, S. A., H. A. Vanderploeg, Brandt, S. B. and T. O. Hook. 2017. Size-mediated control of perch-midge coupling in Lake Erie transient dead zones. Environmental Biology of Fishes 100(2): 1587-1600.

Kolker, A. S., Dausman, A. M., Mead, A. A. Brown, G. L. Chu, P. Y., de Mutsert, K., Fitzpatrick, C. E., Henkel, J. R., Justic, D. Kleiss, B. A., McCoy, E., Meselhe, E. and Parsons Richards, C. 2018. Rethinking the river. Eos: 99, https://doi.org/10.1029/2018EO101169.

Manuscripts in review

Chagaris, D., Farmer, N., De Mutsert, K., Lauretta, M., VanderKooy, S., Schueller, A., Mahmoudi, B., Ahrens, R. Sagarese, S., Patterson, W., and M. Kilgour. Management challenges are opportunities for fisheries ecosystem models in the Gulf of Mexico. Submitted to Marine Policy.

Glaspie, C. N., Clouse, M., Huebert, K. B., Elliot, D. T., Kimmel, D. G., Ludsin, S. A., Mason, D. M., Pierson, J. J., Roman, M. R., and Brandt, S. B. Impacts of hypoxia on the pelagic food web of the northern Gulf of Mexico. Submitted to Estuaries and Coasts.

Roman, M.R., S.B. Brandt, E.D. Houde and J. J. Pierson. Interactive effects of hypoxia and temperature on coastal pelagic zooplankton and fish. Submitted to Frontiers in Marine Science.

Manuscripts In Progress:

Brandt, S. B., Sellinger, C. E., and Glaspie, C. N. Drafted. Seafood diet: Linking fish feeding to habitat, prey availability and bioenergetics in a pelagic predator. For submission to Environmental Biology of Fishes.

Brandt, S.B. Growth rate potential as a Quantitative measure of Fish Habitat Quality. Status: literature reviewed and partially written for Reviews in Fish Biology.

Brandt, S.B., Sellinger C. E. and Glaspie, C. N. Sensitivity of spatially-explicit growth rate potential models to predator swimming speed and reactive distance. Status: initial analyses done and figures drafted. Intended for Trans. Amer. Fish. Soc.

Brandt, S. B., Sellinger, C. E., and Glaspie, C. N. Drafted. Growth rate potential as a causal mechanism for North Pacific salmon returns in a changing climate. For submission to PLOS One.

iii. Patents
iv. New methods and technology
v. New or advanced tools (e.g. models, biomarkers)

New growth rate potential models were developed for red snapper, Atlantic croaker, Gulf menhaden, and brown shrimp.

Growth rate potential modeling framework and plotting/mapping capabilities have been created in an open-source environment (R statistical software).

New Ecospace model, which is an advanced version of the model published in 2016 as mentioned in last year’s report. In the new model, suggestion of the advisory panel are included and the model is representative of 2000, which is the start year of the scenarios run by the hypoxia model we use as driver. The Ecopath model has updated diet and fisheries information and is rebalanced, and recalibrated. The spatial-temporal framework is incorporated in the Ecospace model, which was not the case in the old model. For this, new response curves to oxygen, temperature and salinity are included.

vi. Workshops

Brandt, S. B., and de Mutsert, K. 2018. “Impacts of hypoxia on fishes and food webs in freshwater, coastal and oceanic ecosystems: A global perspective.” Symposium submission accepted, American Fisheries Society Meeting, August, Atlantic City, NJ.

de Mutsert, K., Brandt, S., and Roman, M. 2017. “Ecological impacts of hypoxia on coastal ecosystems.” Coastal and Estuarine Research Federation Biennial Conference, 5- 9 November, 2017, Providence, RI.

Brandt, S. B., and Mason, D. 2017. “Pelagic fish seascapes: Integration of new technology and modeling.” American Fisheries Society Meeting, 20 – 24 August, Tampa, FL.

Glaspie, C.N., Brandt, S. B. 2017. “Response of fishes to extreme climate events.” American Fisheries Society Meeting, 20-24 August, 2017, Tampa, FL.

vii. Presentations

(note: As stated in our proposal some of our tools are being refined and tested in the North Pacific and Great Lakes)

Glaspie, C.N., Brandt, S. B. and C. S. Sellinger. 2017. “Defining energy seascapes to predict distribution and production of fish." Annual Meeting of Ecological Society of America, 6 – 11 August, Portland OR.

De Mutsert, K., Brandt, S., Van Plantinga, A., Lewis, K., Laurent, A., Steenbeek, J., and Buszowski, J. 2017. "Assessing effects of reduced nutrients and hypoxia on living resources in the Gulf of Mexico using a coupled ecosystem modeling approach". American Fisheries Society Meeting, 20 – 24 August, Tampa, FL.

Glaspie, C.N., Brandt, S. B. and Sellinger, C. E. 2017. "Hypoxia impacts on small pelagic fishes: Insights from high-frequency acoustic sensing." American Fisheries Society Meeting, 20 – 24 August, Tampa, FL.

Glaspie, C.N., Brandt, S. B. and Sellinger, C. E. 2017. "North Pacific Salmon habitat quality in response to climate regime shifts." American Fisheries Society Meeting, 20 – 24 August, Tampa, FL.

Sellinger, C. E., Brandt, S. B. and Glaspie, C.N. 2017. "Climate, temperature, and hypoxia as multifaceted drivers of West Coast ecosystems." Coastal and Estuarine Research Federation, 5 – 9 November, Providence, RI.

De Mutsert, K., S. B. Brandt, K. A. Lewis, A. Laurent, J. Steenbeek and J. Buszoeski. 2017. "Simulating hypoxia and nutrient reduction effects on the Northern Gulf of Mexico fishery Ecosystem". Coastal and Estuarine Research Federation, Providence, RI, November 2017.

Glaspie, C. N., Brandt, S. B. and Sellinger, C. E. 2017. "Hypoxia impacts on marine fish trophic dynamics in the Northern Gulf of Mexico." Hatfield Marine Science Center Seminar Series, Newport, OR, December 2017.

Brandt, S., Laurent, A., Glaspie, C., Sellinger, C., and De Mutsert, K. 2018. "Assessing and predicting the effects of reduced nutrients and hypoxia on fishes in the Gulf of Mexico". Ocean Sciences Meeting, February 2018.

De Mutsert, K. 2018. Using ecosystem modeling to evaluate trade-offs in coastal management: effects of large-scale river diversions on fish and fisheries. Network of Experts for ReDeveloping Models of the European Marine Environment (MEME): Innovative modelling in support of Marine Strategy Framework Directive (MSFD) implementation. European Commission Joint Research Centre. Brussels, Belgium, March 2018.

Brandt, S., Laurent, A., Glaspie, C., Sellinger, C., and De Mutsert, K. Abstract accepted. "Assessing and predicting the effects of reduced nutrients and hypoxia on fishes in the Gulf of Mexico". American Fisheries Society Meeting, Atlantic City, NJ, August 2018.

De Mutsert, K., Van Plantinga, A., Brandt, S., Glaspie, C., Lewis, K., Laurent, A., Buszowski, J. Abstract accepted. "Using a Coupled Ecosystem Modeling Approach to Evaluate Effects of Reductions in Nutrients and Hypoxia on Living Marine Resources". American Fisheries Society Meeting, Atlantic City, NJ, August 2018.

viii. Outreach activities/products (e.g. website, newsletter articles)

Upon recommendation by the advisory panel, the website has been made into a one-stop shop of all information related to this project: https://demutsertlab.wordpress.com/ngomex/

b. Management outcomes – I. Management application or adoption of:

i. New fundamental or applied knowledge
ii. New or improved skills
iii. Information from publications, workshops, presentations, outreach products
iv. New or improved methods or technology.
v. New or advanced tools.

c. Management outcomes - II. Societal condition improved due to management action resulting from output (examples: improved water quality, lower frequency of harmful algal blooms, reduced hypoxic zone area, and improved sustainability of fisheries).

d. Partnerships established with other federal, state, or agencies, or other research institutions (other than those already described in the original proposal).

During year two of the project no workshops were scheduled on the milestone chart and thus none were held. We did conduct three of the four scheduled advisory panel calls to provide project updates to our panel. These calls have primarily consisted of short updates on the progress with the modeling tool, querying the panel for scientific advice relative to the models, querying the panel for updates on any pertinent managerial actions that our group should focus attention towards (e.g. upcoming stock assessments), and providing information on scheduled meetings where individuals can interact with the modeling team. We held two ad hoc meetings in association with larger conferences including the American Fisheries Society (AFS) Annual Meeting in Tampa Bay, and the Coastal and Estuarine Research Federation (CERF) Annual Meeting in Providence. In addition at the CERF meeting, project leads organized a special session on hypoxia modeling with other NGOMEX funded project leads. Project leads also helped organize, attended and presented updates during the Fisheries Monitoring Workgroup workshop held at Stennis Space Center this spring. With the help of Kevin Craig (application PI on the other two projects) we have begun to make inroads with NOAA's shrimp stock assessment group in Galveston. Kevin is scheduled to travel to Galveston to meet with the assessment team and will provide updates on the various NGOMEX projects and how the various tools could help their assessments. Kim de Mutsert continues to work closely with members of NOAA's Integrated Ecosystem Assessment (IEA) group on this and other projects and thus we are positioned to interact with this group at upcoming federal assessments. Advisory panel members will be provided another opportunity to interact with the modeling team at the AFS annual meeting scheduled to be held in Atlantic City in August. Finally we included Chris Kelble and Ted Switzer on the advisory panel given their leadership rolls and expertise with the IEA group (Chris) and SEAMAP advisory group activities (Ted). We will continue to have quarterly calls to maintain dialogue with our advisory panel and will be working to establish better relationship with management level individuals (e.g. Gulf Council members).

3. Expenditures:

a. Describe expenditures scheduled for this period.

The expenses for the reporting period (June 1 2017-May 31, 2018) are listed in the brown column called "Expenses Between Start and End Month". The first table provides the budget of the main grant, the second table the budget of the participant support grant, which is the funds allocated to organizing the workshops within this project.

The other columns in the budget report represent the total amount of funding received so far ("Funded Amount Thru End Month"), all expenses made so far ("Expenses Thru End Month"), funding committed but not spent yet ("Commitments Thru End Month), and funding available/not spent yet ("Available

Amt"). Expenditures during the reporting period included post-doc salary for Alex Van Plantinga ("Faculty Salaries"), Summer salary for Dr. de Mutsert ("Faculty Special Payments"), wages for student workers, consulting services (salary for Arnaud Laurent and Joe Buszowksi), travel (conference attendance), the Oregon State University subcontract (itemized below), and other direct expenditures, which include publication cost, and computer software upgrade costs.

The 'other direct expenditures' in the participant cost budget was a delayed charge for printing of the name tags and agendas for the first workshop that took place in February 2017. There was no workshop scheduled for this reporting period, so no other costs were incurred during this period that fall under participant support.

PI Report by Month Range

June 20, 2018 Start Month: Jun-2017 End Month: May-2018 Page 1 of 1

Fund: 203952 **Project:** NOAA/NGOMEX 2016: Gulf of Mexico **Org Desc:** PEREC Grants & Contracts

Grant: 203952 **Agency:** National Oceanic & Atmospheric Admi **PI:** De Mutsert, Kim

Grant Start Date: 09/01/2016 **Grant End Date:** 08/31/2020

Acct Pooled Budget Level Group	Pooled Budget Level		Funded Amount Thru End Month	Expenses Between Start and End Month	Expenses Thru End Month	Commitments Thru End Month	Available Amt
Direct	61100	Faculty Salaries	55,703.00	40,920.34	48,293.52	0.00	7,409.48
	61130	Faculty Special Payments	13,809.00	4,702.55	4,702.55	0.00	9,106.45
	61400	Wages	10,704.00	3,554.75	5,663.75	0.00	5,040.25
	61900	Fringe Benefits	20,159.00	14,596.79	17,102.10	(0.00)	3,056.90
	73400	Consulting Services	52,381.00	11,950.00	19,950.00	19,810.00	12,621.00
	73800	Travel	12,365.00	2,199.03	8,596.35	0.00	3,768.65
	73600	Subcontracts (25K or Less)	25,000.00	0.00	25,000.00	0.00	0.00
	73700	Subcontracts (GT 25K)	201,834.00	89,722.75	102,463.17	99,370.83	0.00
	70000	Other Direct Expenditures	7,032.00	3,677.01	3,677.01	0.00	3,354.99
	Direct Total		**398,987.00**	**171,323.22**	**235,448.45**	**119,180.83**	**44,357.72**
Indirect	79000	Indirect	102,518.00	42,432.32	69,152.41	0.00	33,365.59
	Indirect Total		**102,518.00**	**42,432.32**	**69,152.41**	**0.00**	**33,365.59**
Total			**501,505.00**	**213,755.54**	**304,600.86**	**119,180.83**	**77,723.31**

PI Report by Month Range

June 20, 2018 Start Month: Jun-2017 End Month: May-2018 Page 1 of 1

Fund: 203953 **Project:** NOAA/NGOMEX 2016: Gulf of Mexico PS **Org Desc:** PEREC Grants & Contracts

Grant: 203952 **Agency:** National Oceanic & Atmospheric Admi **PI:** De Mutsert, Kim

Grant Start Date: 09/01/2016 **Grant End Date:** 08/31/2020

Acct Pooled Budget Level Group	Pooled Budget Level		Funded Amount Thru End Month	Expenses Between Start and End Month	Expenses Thru End Month	Commitments Thru End Month	Available Amt
Direct	73800	Travel	0.00	0.00	290.60	0.00	(290.60)
	70000	Other Direct Expenditures	8,922.00	49.84	457.84	0.00	8,464.16
	Direct Total		**8,922.00**	**49.84**	**748.44**	**0.00**	**8,173.56**
Indirect	79000	Indirect	0.00	(212.16)	0.00	0.00	0.00
	Indirect Total		**0.00**	**(212.16)**	**0.00**	**0.00**	**0.00**
Total			**8,922.00**	**(162.32)**	**748.44**	**0.00**	**8,173.56**

OSU subcontract detail

May 31 marks the completion of 21 months of this project. OSU Expenditures are right on schedule as described in the original proposal. In the original budget, over 85% of costs were planned for salary for Brandt, Sellinger and a Postdoctoral Scholar, (C. Glaspie) and associated Fringe (OPE) and Overhead (F&A) with the balance for Travel and Supplies. There have been no unanticipated costs. We plan to spend funds largely as originally allocated. Salaries for Sellinger and Glaspie cover a percentage of their time and are paid monthly. Brandt's salary has not yet been charged but will likely be paid during the summer months.

A summary of expenditures (to the nearest dollar) as of 31 May, 2018 is below. Additional expenditures to cover Salary, OPE and Indirect for Brandt and encumbered for Sellinger and Glaspie through August total $51,957.

	Expenditures by 31 May	Full allocation
Salaries	70,057	108,075
OPE	12,558	27,824
Supplies	893	3,010
Travel	12,428	15,400
F&A	44,997	72,525
Total	140,993	226,834

b. Describe actual expenditures this period.

See budget tables above (under 3a).

c. Explain special problems that led to differences between scheduled and actual expenditures, etc.

A budget reallocation was completed during this reporting period to allocate more funding to OSUs subcontract when the contract of GMU’s post-doc ended, and the OSU post-doc was shared. The additional funding was to fund half of Cassie Glaspie’s salary. In addition, more funds were allocated to participant support, to allow for workshop two (taking place in the next year of support) to take place in Miami, and support the advisory panel to travel there.

Prepared by:

06/25/2018

Signature of Principal Investigator Date

NOTICE

Subsequently, all NOAA COP recipients with approved grants will be asked to file a COP Project Final Report in the specified format upon expiration or termination of grant support. Consistency in reporting requirements for competitive research grant programs is desirable and this is behind COP's efforts in proposing a standardized format. The use of the Project Final Report format will provide the level of detail required to evaluate the effort invested by investigators and staff on project management; any actual accomplishments and research findings; and what goals and objectives were attained. The proposed final report format is compatible with the format in use by other agencies that participate in joint projects with COP, e.g. the National Science Foundation.

Public reporting burden for this collection of information is estimated to average 300 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed and completing and reviewing the collection of information.

Send comments regarding this burden estimate or any other aspects of this collection of information, including suggestions for reducing this burden, to the National Ocean Service, CSCOR/COP Office, 1305 East-West Highway, Silver Spring, MD 20910. Grant files are subject to the Freedom of Information Act (FOIA). Confidentiality will not be maintained--the information will be made available to the public. However, unpublished research results shall not be published without prior permission from the recipient.

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the Paperwork Reduction Act, unless that collection of information displays a currently valid OMB Control Number.