Oyster Futures

Stakeholder Workgroup

3RD MEETING SUMMARY REPORT

November 5-6, 2016
Horn Point Laboratory, University of Maryland
Cambridge Maryland

Summarized by:

FCRC CONSENSUS CENTER

"Facilitating Consensus Solutions, Supporting Collaborative Action."

THE FLORIDA STATE UNIVERSITY

Oyster Futures Workgroup, November 2016

Oyster Futures Workgroup, Facilitators and Research Team

OysterFutures Stakeholder Workgroup
November 5-6, 2016 Meeting III Summary Report

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OYSTERFUTURES WORKGROUP
MEETING EXECUTIVE SUMMARY
NOVEMBER 5-6, 2016

On behalf of the Oyster Futures Research Team, Elizabeth North welcomed the Members to the third meeting of the OysterFutures Workgroup and introduced the facilitation team of Jeff Blair and Bob Jones with the FCRC Consensus Center at Florida State University. Following workgroup member introductions, the facilitator noted the importance going forward of getting as close as possible full participation in the Workgroup meetings as they develop initial recommendations to the Department of Natural Resources in 2017.

The facilitators reviewed the agenda and the Workgroup approved the agenda and the April 2016 Workgroup meeting summary. The facilitator then reviewed the workgroup Goal statement adopted at the organizational meeting in February 2016 and which calls for a package of Workgroup consensus recommendations informed by modeling collaboratively developed by the Workgroup and the OysterFutures project research team later in 2017.

OysterFutures Simulation Model. Mike Wilberg and Elizabeth North provided an overview of the OysterFutures modeling tool components that included the Population and Fishery Dynamics Model, the Economics Model, and the Water Quality Model. Mike noted that there would be up to 6 pieces that would be combined into the overall OysterFutures simulation model. He noted that the simulation model was being designed to forecast the performance of each of the Workgroup options related to stocking, habitat restoration and regulatory enforcement, and business incentives.

Oyster Population Models. Dr. Wilberg first introduced the oyster Population models noting that they are based on an assessment that provides estimates of oyster abundance, fishing and natural mortality rates, and how the fishing effort relates to fishing mortality. These estimates will be used in the OysterFutures simulation model to describe how the oyster population is expected to change over time. The Population model will be "tuned" with Workgroup input until it fits data that are provided to it. That "tuned" model in turn provides the estimates of oyster abundance and mortality rates for the OysterFutures simulation model.

The Population models will combine data from the fishery, DNR fall survey and harvest reports to get the best estimates of mortality and abundance. The data is drawn from 1988-89 to 2014-15 and includes harvest estimates (75% reported); trends in oyster and box density from the Maryland DNR Fall dredge survey; size and disease prevalence/intensity data; hand tong and power dredge bushels per hour at the beginning and end of the season; numbers stocked; and amount of shell placed (or other materials).

So far the Population models for Lower, Middle and Upper Choptank River, Broad Creek and Tred Avon are going well. The Sanctuary Harris Creek and Little Choptank are next on list to do for the modelers. The Workgroup questions and discussion covered the following topics providing input back to the modelers for each: Harvest reporting estimates; Spat estimates; Harvest time; Estimating habitat density; Exploitation rates; and Natural mortality.

Mike Wilberg next described the OysterFutures simulation model which was being built for the stakeholders so they could evaluate different options with it. He noted that the simulation model would use information from the Population models and would include information on oyster reproduction, larval transport, growth, mortality, bottom habitat and fishing effort. He reviewed the draft assumptions for starting oyster abundance, oyster density and habitat, fishing effort, reproduction, and maximum number of spat for workgroup input. He then described the related performance measures which would be predicted by the simulation model, including oyster abundance, harvest, number of participants, profit, amount of shell on reefs, water clarity and nitrogen reduction. Drs. Wilberg and North then reviewed and answered Workgroup questions on the following model areas: Fishing Effort; Fishing Selectivity; Economics; Water Quality; Habitat degradation; Oyster Growth; and Natural Mortality.

Mike Wilberg reviewed charts showing multiple runs of the OysterFutures simulation model with randomness built in to reflect the difficulty in future predictions. The charts were intended to show the types of results, but not for drawing specific conclusions. He noted three scenarios were initially chosen because they were easy to run with the model and included: 1. Status quo management of sanctuaries and regulations; 2. Hand tong everywhere; and 3. Sanctuaries everywhere. He urged the Workgroup not to focus on specific numbers but check if the relationships generally make sense. He reviewed oyster abundances, harvest, fishery revenue, and ecosystem services for all regions.

Elizabeth North asked Workgroup members to take a step back and comment on the big picture. Does the modeling appear useful and on the right track? The Workgroup agreed that the challenge is to put all of this into one model and felt it was moving in the right direction with additional fine tuning regarding shell loss and degradation, recent fishing practices, and the amount of 3-D habitat for other organisms. It should be a valuable tool for the Workgroup to use when considering a series of management options.

Larval Transport Model. Elizabeth North noted that the predictions from the Larval Transport Model will be used in the OysterFutures simulation model to forecasts how oyster larvae spawned in one region travel to another. The Larval Transport Model uses predictions of salinity, currents, and turbulence from a hydrodynamic model. They will use the abundance estimates from the Population model combined with the larval transport model to see if we get the same spat fall patterns as those measured by DNR during the fall survey. She also reviewed the use of the NOAA geodatabase which includes maps of different habitat types based on acoustic surveys. The Workgroup members discussed and noted the need for ground-truthing and spot-checking in areas.

Economic Models. Lisa Wanger and Chris Hayes on the Research Team presented their work in developing economic models to contribute to the overall OysterFutures model. Chris Hayes presented the preliminary net revenue model to get Workgroup feedback on its assumptions. The Workgroup suggested the need to adjust these estimates to more accurately reflect the real costs,

including costs for gear types and distance traveled. It suggested the research team not rely on a limited, dated and likely flawed survey conducted in 2006. Chris agreed to try to go out and redo the survey to get better data to inform the net revenue model. There was also discussion of whether the model could value ecosystem services. The researchers noted that, although "value" is very specific to location and it is hard to put accurate values on ecosystem services, the team likely would be able to estimate a value related to nitrogen reduction.

Water Quality Models. Rasika Gawde presented on the Three Dimensional Water Quality Model applied to the Choptank and Little Choptank Rivers. Raleigh Hood and Elizabeth North have worked with Rasika in conducting this research. The model is designed to calculate how fast algae grows and dies, how seston and other particles move through water, how nitrogen and dissolved oxygen levels change, and how all of these processes respond to oyster filtration. The researchers plan to use the Three Dimensional Water Quality Model to develop relationships between the number oysters and their influence on light availability in the water column, the amount of seston in the water for each area with different water flows, etc.

Melanie Jackson provided a presentation on nitrogen removal and oyster reef ecosystem services. Nitrogen runoff and pollution fuels algae growth. Without oysters, algae and particles stay in the water column for a long time before settling. Oysters remove algae and solids from the water column and turn them into bio-deposits. Oyster shells and bio-deposits create an ideal environment for nitrogen removal. She noted in summary that oysters store nutrients in their shell, more oysters means more nitrogen removal and hard shells create a better habitat for organisms and nitrogen removal. The Workgroup asked questions and discussed the following topics: Bio-deposits and worms; Aquaculture gear types; Floating cages; and Soil chemistry for undisturbed vs. dredged reefs.

Review of Workgroup Options and Input to Modeling. The Workgroup reviewed and discussed and provided input to the modeling work and questions for those nine option areas that had achieved a consensus rating of 75% or greater in the Workgroup's April 2016 meeting including: Rotational Harvest Options; Enforcement Options; Use of Population Assessment in Management Options; Limited Entry Options; Habitat Modifications/Restoration Options; Fee & Tax Option; Spatial Options; Regulations Related to Specific Gears Options; and Stocking Options

Rotational Harvest Options. Mike Wilberg noted the key modeling questions are: what frequency of rotation should be modeled; should it use the Rappahannock River, Virginia approach with a three year rotation in three areas with 2 areas open at any given time? The model has 608 regions represented by polygons, some big and some very small. Should it include individual bars? He noted the modelers could add habitat in the model. How should the model address Sanctuary areas vs. currently harvestable bottoms? How should shell/spat enhancement be conducted? The Workgroup asked questions and discussed the following topics: Treatment of Sanctuary areas in the model; Addressing the number of licensed watermen; Addressing Federally funded restoration; Dividing areas into sections; and is there room for rotation in the public fishery?

Enforcement Options. Mike Wilberg noted the model incorporates harvest of undersized oysters. He asked the Workgroup to what degree they want to focus on harvesting in closed areas in the model? The Workgroup questions and discussion provided input to the modelers on the following topics: Illegal harvest; How to model better enforcement; Use of monitoring seed data; Underwater drone surveillance; Oysters planted on rock and physical deterrent.

Use of Assessment of Population. Michael Wilberg noted this topic was subject to oyster stock assessment legislation in Maryland and that he has been asked by the Maryland DNR to help with the legislatively directed oyster stock assessment.

Limited Entry Options. Mike Wilberg highlighted some key questions for modeling that include: where should the number of licenses be? Should it be income-based, harvest based? What years do you pick? Of 5000 DNR licenses, 3000 are TFL umbrella license holders and of those about 500-800 are oyster licenses. It is capped at about 3800. Watermen can only harvest if they pay an oyster surcharge? The Workgroup questions and discussion provided input to the modelers on the following topics: Full vs. Part time watermen; Limiting entry to the fishery; Declining opportunities for watermen; Test scenarios with the model; License Surcharges; Use or lose license scenario; Establishing the number of watermen and harvest levels; Consider an oyster only license; Drug testing; License impact on families; Impact on younger watermen; Limit license and increase it value; and Increase oyster population first.

Habitat Modification/Restoration Options. Mike Wilberg asked if there were specific locations that might work for testing? Otherwise the model will focus on areas with information about water quality and habitat. The Workgroup questions and discussion provided input to the modelers on the following topics: Artificial reefs; Sediment changes; Model for storms; Man-made habitat adjacent to natural oyster bars; Lower Choptank River; Level of funding for sustainability; and Loss of shell.

Fee and Tax Option. Mike Wilberg noted that this option has been covered in terms of limited entry. In terms of specific options, he noted the model could test the impact of doubling the bushel tax and the oyster surcharge. The Workgroup questions and discussion provided input to the modelers on the following topics: Limited entry to public areas; Eliminate bushel tax; USDA aquaculture funding; Oyster tax vs. export tax; Increase export tax vs. bushel tax; License surcharge; Eliminate the bushel tax and double the surcharge; and Fund more bottom habitat.

Spatial Options. Mike Wilberg noted we already talked about locations where management or restoration efforts take place and what activities are allowed or not. The Workgroup questions and discussion provided input to the modelers on the following topics: Loss of Sanctuary bottom; Prioritizing funding; Encourage Less Destructive Gear; GIS Reporting Technology; and Sanctuaries on the Dorchester side.

Specific Gear Options. Mike Wilberg already talked about locations where management or restoration efforts take place. If areas in sanctuary are open in a model scenario, should it be for hand tong only? The Workgroup questions and discussion provided input to the modelers on the following topics: Areas and gear types; and Mortality data for gear types.

Stocking Options. Mike Wilberg indicated the key modeling questions are where to stock and how often and how much. Should we model differences in how spat survive and grow on shell or chip? The Workgroup questions and discussion provided input to the modelers on the following topics: Alternatives to spat on shell; Rebuild habitat first; Federal funding for aquaculture.

Next Steps and Communication Strategy. The modeling team suggested they would have an operational model with habitat, fishing effort and economics having the full spatial scale of all the regions including the Little Choptank ready for stakeholder use in March 2017. They agreed to reschedule the January 2017 meeting and meet on March 24-25, 2017. Following the March meeting

the schedule for the 1st phase calls for two more meetings in May and July to reach agreement on the Workgroup recommendations to DNR. The facilitator noted the critical importance of participation of all stakeholders going forward to make the most of the process and at the conclusion of the March meeting the Workgroup and Research Team would confirm the schedule for the next two meetings.

Elizabeth North noted videos from the OysterFutures Symposium in St. Michaels should be on YouTube before Christmas. She noted much was learned from the symposium and the exit surveys indicated very high scores for the Symposium with the panels and Q & A dialogue rating the highest.

Elizabeth North noted the importance of the OysterFutures communication strategy in getting word out on the options under consideration to the broader watermen community. There was discussion of whether to convene any workshops on the Workgroup's recommendations prior to submitting to DNR in the summer such as public workshops in each county. It was agreed to discuss this and make a decision at the March meeting. There was also discussion of how the output from OysterFutures connects with the Oyster Advisory Commission. It was agreed that the Workgroup needed to get further down the road in its work (following the May 2017 meeting) before connecting with the OAC.

At the conclusion of the meeting the Workgroup members went around the table to offer comments on the meeting and completed meeting evaluations.

OYSTERFUTURES WORKGROUP
ORGANIZATIONAL MEETING SUMMARY
NOVEMBER 5-6, 2016

I. OVERVIEW OF THE OYSTERFUTURES CONTEXT

A. WORKGROUP INTRODUCTIONS & SCHEDULE

On behalf of the Oyster Futures Research Team, Elizabeth North welcomed the Members to the third meeting of the OysterFutures Workgroup and introduced the facilitation team of Jeff Blair and Bob Jones with the FCRC Consensus Center at Florida State University. Following workgroup member introductions *(See Appendix #2 for the Workgroup members list)*, the facilitator noted the importance going forward of getting as close as possible full participation in the Workgroup meetings as they develop initial recommendations to the Department of Natural Resources in 2017.

Mike Wilberg and Elizabeth North provided an overview of the OysterFutures modeling tool components indicating there will be up to six parts that will be combined into the overall model including the Population and Fishery Dynamics Model(s), the Economics Model, and the Water Quality Model. He noted that each of the Workgroup options related to stocking, habitat restoration and regulatory enforcement, and business incentives will include related performance measures that the model will utilize.

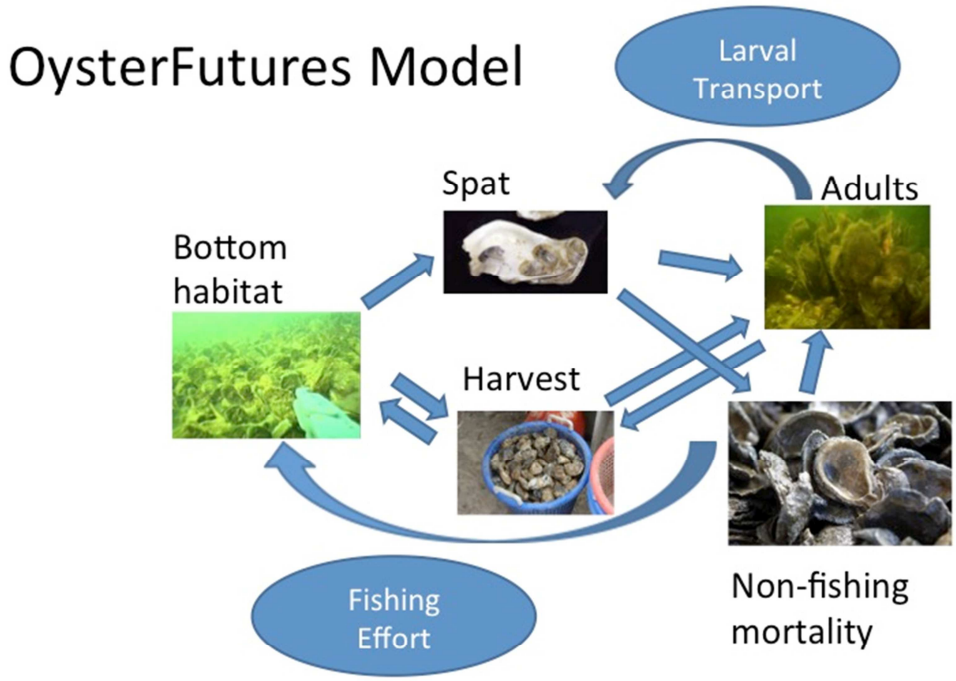
Elizabeth North asked whether different meeting scheduling options might produce more watermen participation. It was noted there would be an attendance problem after March due to the crabbing season. The facilitator suggested discussing the schedule and strategies for watermen participation on the 2nd day when more workgroup members were expected.

B. REVIEW OF AGENDA AND WORKGROUP GOAL

The facilitators reviewed the agenda and the Workgroup approved the agenda *(See Appendix #1)* and the April 2016 Workgroup meeting summary. The facilitator then reviewed the workgroup Goal statement adopted at the organizational meeting in February 2016 which calls for a package of Workgroup consensus recommendations informed by modeling collaboratively developed by the Workgroup and the OysterFutures project research team.

II. UPDATE ON THE DEVELOPMENT OF THE OYSTERFUTURES SIMULATION TOOL

Mike Wilberg and Elizabeth North provided an overview of the OysterFutures modeling tool components that included the Population and Fishery Dynamics Model, the Economics Model, and the Water Quality Model. Mike noted that there would be up to 6 pieces that would be combined into the overall OysterFutures simulation model and offered the illustration below to indicate what the simulation model was trying to replicate. He noted that the simulation model was being designed to forecast the performance of each of the Workgroup options related to stocking, habitat restoration and regulatory enforcement, and business incentives.



A. Population and Fishery Dynamics Model Review

Dr. Wilberg first introduced the oyster population model noting that it is based on an assessment that provides estimates of abundance and fishing and natural mortality rates and estimates how the fishing effort relates to fishing mortality. These estimates help in building the model to describe how the population is expected to change over time and to provide the starting levels of abundance at the beginning of the time series.

He noted that the population models combines data from the fishery, DNR fall survey and harvest reports to get the best estimates of mortality and abundance. The data included are from 1988-89 to 2014-15 and include harvest estimates (assuming 75% reported); trends in oyster and box density from the MD DNR fall dredge survey; hand tong and power dredge bushels per hour at the beginning and end of the fishing season; numbers stocked; and amount of shell placed (or other materials).

So far the population models for Lower, Middle and Upper Choptank River, Broad Creek and Tred Avon are going well. The Sanctuary areas in Harris Creek and Little Choptank are next on list to do for the modelers

Workgroup Comments and Questions

- **Harvest reporting estimates**. How did you determine to use 75% of harvest estimates reported? *A: From discussions with DNR.*
- Watermen believe this is closer to 90-95% rate of reporting with fewer people participating, introduction of tagging around 2010 and steep fines. Not reporting from the area where oysters were caught and the percentage of under-reporting was higher 20 years ago. *A: We are looking to provide a realistic number drawing on workgroup knowledge and data records, and will revise the number accordingly.*
- **Spat estimates.** How do you get negative numbers on spat? A*: The analysis was done on logarithmic scale. In the future, the estimates will be transformed back to usual numbers that make more sense.*
- Spat fall information may indicate problems as Code 3 areas have the best spat sets. *A: Good point. Will look at survey data from this region and will get better information and this may change.*
- **Harvest time.** How is harvest time calculated? Is it actual time or time from leaving the dock? What is this collected for? *A: The time is the number of hours noted in the watermen reports. We look for consistent reporting to help interpretation. We are using it to determine whether and how harvest and the amount of effort declines from the beginning to the end of a season.*
- Note that the Department of Health requires reporting the time that oysters were pulled up to the time they were placed in refrigeration.
- **Estimating habitat density.** Do Broad Creek estimates make sense? *A: It reflects the amount of harvest supported overtime and does not provide an ecological perspective. Models use information about where the harvest is coming from and how many oysters were caught in DNR's fall dredge survey. Those numbers are highest (i.e. highest density) from Broad Creek based on using the model to integrate all the data. Currently it is showing that Broad Creek has three times more oysters than the Upper Choptank River, six times higher than the Middle Choptank, and ten times higher than the Lower Choptank.*
- Are these estimated densities based on harvest reports? *A: Yes, and they also incorporate DNR fall survey data. We need these estimates of abundance as a starting point for the model to be able to evaluate options. It might be possible to do an independent check on model estimates with divers. These should be comparable. We also will compare model predictions with patent tong surveys. Habitat maps including Harris Creek are from 2012. Any restoration activities since then are not incorporated into habitat map we are starting from.*
- Do differences between different regions make sense? *A: Yes – there are problems in different parts of bay where spat won't catch. These relative differences make sense. Broad Creek- high density. Seems like a lot of oysters. Patent tong work reflects what DNR has measured with their dredge.*
- What about Harris creek? *A: We haven't done that yet as we went from easy to harder. Sanctuary and Restoration efforts make it harder to get the data and the model will need to be changed. Harvest data shows how many oysters were removed. Fall dredge survey data shows the changes in population.*
- Why the downturn in Tred Avon in 2015? *A: The Sanctuary is putting seed there but there was no planting of spat in 2015. We will need to account for reef building efforts in Harris Creek.*

- Have you accounted for the change in the timing of the Fall survey? Last year it was conducted before dredging, this year it will be after. *A: We will need to address this in the model.*
- How did you define the Upper Choptank River areas? There has not been recent harvest in the Upper Choptank River so does the model account for the variation? A*: We are using survey data. The model uses the fall dredge survey for estimating abundance, but with less harvest we have greater uncertainty. Harvest data is the only date we know as all other data is relative. The pattern of harvest is included in the model.*
- How does the model deal with replenishment? A*: the Seed program for the Upper Choptank ended in 2007 with not much planted or harvested since. This may explain the density in upper Choptank.*
- **Exploitation rates.** 70% harvest rate seems high in terms of sustainability. *A: It is pretty high for how fast oysters grow and reproduce. The figure is a byproduct of same model estimating density. The harvest caught is divided by abundance at beginning of season with October 1 as the starting date.* The exploitation *rates are model estimates and are not data-based. They follow a general trend with the 1980s experiencing a high exploitation rate that declined 1990s-2000s and rebounded in the last 10 years except in Sanctuary areas. Last year's Broad Creek estimates are uncertain.*
- **Natural mortality.** How bad is natural mortality for this region? *A: During the drought years of 2000-2002 there were high natural mortality rates. Broad Creek natural mortality was estimated to be 10-15% while outside of Broad Creek the other areas had higher levels (30%) no oysters over 4 inches. Mortality rates for large oysters were higher. The average rate was 15-20% minus disease impacts. We are using these population models to try to get how many oysters are out there now and to estimate the rate of natural mortality for use in the OysterFutures simulation model. We also are trying to develop the relationship between how many trips watermen take vs. how many oysters are out there. Given density of oysters in model, what should the catch rate (bushels per hour average) be if population density is at a certain level.*

Mike Wilberg next described the OysterFutures simulation model which was being built for the stakeholders so they could evaluate different options with it. He noted that the simulation model would use information from the population models and would include information on oyster reproduction, larval transport, growth, mortality, bottom habitat and fishing effort. He reviewed the draft assumptions for starting oyster abundance, oyster density and habitat, fishing effort, reproduction, and maximum number of spat(depending on habitat quality) for workgroup input. He then described the related performance measures which would be predicted by the simulation model, including oyster abundance, harvest, number of participants, profit, amount of shell on reefs, water clarity and nitrogen reduction.

He then reviewed the following model areas with the Workgroup:

- **Fishing Effort.** Mike Wilberg noted that they are using bushels per hour and number of trips. Higher harvest results from more trips. He suggested the Workgroup should expect to see major changes on this part of the model at the next meeting.
- How hard is it to increase model data up to 2015 and include recent restoration work? It may change overall numbers in terms of how model will look. Every year we can include will make a difference. *A: It might be possible to put additional data in the model such as last year's*

fishing season and fall dredge survey. We will check with DNR to see if they are available and will include if they are.

- Does this include power dredging? *A: Yes*
- **Fishing Selectivity.** DNR estimates that 10% per harvested bushel are small when most of the oysters in the water are around 2 ½ inches.
- Only allowed 5%? All of us would be arrested. *A: Regulation is not as strictly followed as written.*
- Is the model structured on the legal mandate? *A: We are trying to structure the model based on what happens. However, we are nervous about building illegality into the model. This is the conundrum of evaluating policy options, but it is important to haves an accurate depiction of the effects on an option if pursued. The modelers will try to represent effects of additional enforcement.*
- Consider running the model with both 5 and 10% reflected which would account for a few bad guys with 10%.
- Will this be early vs. later in season? *A: not reflected in the model now but plan to include. Structure so that in the beginning of the season most are following rules. End of the season with fewer oysters, may be lax on what they are doing and end with 20-25% harvested that are undersized. Won't have as many people fishing at the end of the season.*
- Natural Resources Police (NRP) record of all stops and citations. If this data is available you can use it to fine tune the model. *A: would love that data as it would eliminate broad brush concerns.*
- Can you run it both ways to determine how effective enforcement could be? *A: Yes.*
- **Economics.** Economics is slippery slope. If Louisiana oysters come back we'll be in trouble and oyster prices will drop. *A: Modelers are aware of this. These include general estimates of revenue in terms of dockside value of harvest. Average monthly price per bushel.*
- **Water Quality.** This reflects nitrogen and particle removal and filtration (i.e. feces removed from water). Will add water clarity in next versions.
- **Habitat degradation**. In Maryland, there appears to be 16% per year loss of shell, whereas in Virginia it is 35% per year because there are more shell-boring organisms. In New Jersy the shell loss ranges between 6%-30 per year, with 18% average shell loss.
- **Growth.** How big are oysters at a given age? *A: Based on ORP stockings from 1990s-2008, oysters grow to about 3 inches by 2 years of age and all oysters are about the same size by 4 years. Variability in size is built into model and we will show the data behind the size versus age relationship at the next meeting.*
- Didn't grow after 4 years? *A: Not much. Consistent with other shell fish.*
- Not getting big female producing oysters because growth slows downafter 4 years? *A: Yes, on average.*
- What causes fossilized degradation? *A: Sediment covers the shell and causes fossilization.*
- **Natural Mortality.** The simulation model is using the estimates from 2005 forward to characterize mortality rates. This makes the assumption that high mortality events are unlikely to occur in future. Oysters may have developed disease resistance to present-day pathogens. We can run scenarios that include high disease to see the effects on options if the previous disease dynamics come back.
- 50% mortality on spat? A*: Yes, that is from the first fall until the next Fall. As they get bigger, their mortality rates decline. In the 2nd part of the OysterFutures process (meetings in 2018), we will*

build big disease events into the model in terms of the role of temperature over time. Will be important to do big pulses of disease to inform 2nd round.

- Seeing small pockets of death up to 40-50%. Hoping it is not something new beyond dermo? *A: will model high mortality rates of the past and look at performance under those conditions. That is how the model structured. In more recent years there is some evidence that resistance to MSX and Dermo has evolved in oyster populations in Chesapeake Bay, so we don't expect high mortality rates in the near-future. We haven't had a disease event since early 2000s.*
- Is there consensus in the science community on disease resistance? *A: There is not a consensus.*
- Important to come to consensus on disease resistance building naturally and curtailing rate of mortality. Think of planting disease resistance oysters. *A: For the model to work we don't have to decide whether disease resistant has evolved or not. Performance of the options might not depend on disease mortality rates, and we can use past and present mortality rates to evaluate each option. We won't be able to come up with a definitive story about what has happened with disease in the time course of this project – the scientific debate won't be resolved by mid 2017 when stakeholders are scheduled to make recommendations to Secretary Belton.*

B. Overview and Discussion of Initial Model Scenarios & Simulations

Mike Wilberg reviewed charts showing multiple runs of the OysterFutures simulation model with randomness built in to reflect the difficulty in future predictions. The charts were intended to show the types of results, not for drawing specific conclusions. For example, one chart depicted spat abundance in each region, with the chart representing the results of over 50 runs at year 15 and year 25.

He noted three scenarios were initially chosen because they were easiest to run with the model and included:

1. Status quo management of sanctuaries and regulations;
2. Hand tong everywhere with regulations and hand tong only in Sanctuaries; and
3. Only Sanctuaries scenario.

He urged the Workgroup not to "hang their hat" on specific numbers but check if the relationships generally make sense. He reviewed habitat density, quality, harvest, fishery revenue and ecosystem services for all regions. The Workgroup asked questions and discussed the following topics:

- **Randomness.** What is an example of built in randomness? A*: a big one is larval mortality; early spat mortality; natural mortality; different amount of fishing at different sites, etc.*
- Will the model have random mortality events built in? A*: It will have variability and randomness in mortality, consistent with ranges observed , both recently and in the past.*
- Habitat quality determines how many spat can settle in an area which generate additional shell in the absence of other activities.
- **Shells and restoration.** Is shell most important for restoration? *A: Shell portion is important but so is how watermen respond to regulations.*

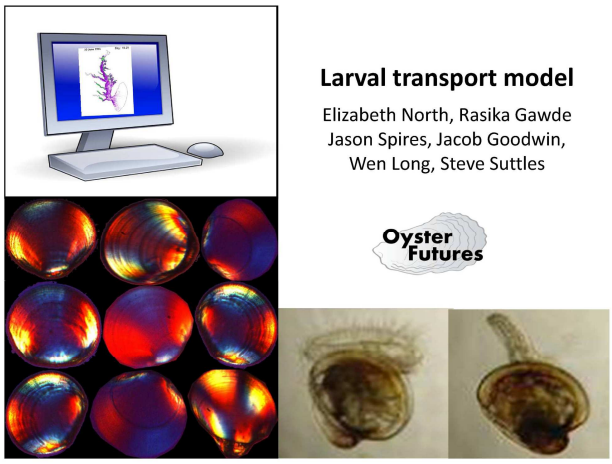
- What about a dominant year class or two? *A: It is already built into the model in terms of the difference in larval and early settlement rates.*
- **Planting spat.** Does this reflect Watermen planting spat? *A: There is no additional spat planting or shell addition in the model. However this can be built in as an option.*
- **Model Regions.** Are the 608 oyster bars relatively equal in size? *A: No, they are unequal in size.*
- **Habitat density.** Each habitat has oyster density associated with it. How was this determined? *A: We used habitat scores and patent tong survey data from pre-sanctuary/restoration efforts. We looked at the density of oysters by habitat score and used that information to assign the total number of oysters in the whole region to the different oyster bars.*
- Might be useful to separate by habitats and compare results.
- **Sedimentation** as a factor in degradation. Is the sedimentation rate changing for a 3D reef system? *A: The effect of 3D structure on sedimentation rates is not currently in the OysterFutures simulation model. Oysters that are sticking up may increase sediment rates on oyster itself. If a large reef is up in water, this will change the way that water flows around it. The rough surface on bottom causes the water to slow down and could leaves sediment deposits behind the reef or, if long enough, on some of the oysters. The OysterFutures simulation model does forecast that a certain number of oysters in area will produce a certain amount of shells, and if shell loss (which includes average sedimentation rates) is higher than shell production, the area will suffer long term decline.*
- **Number of Model Runs.** What is the difference between running 50 vs. 1000 simulations? *A: We expect it will show more variability with more simulations. We could plot results for each of the 608 regions in the models, but the trade off will be between how finely you look at results vs. how many results you can look at. We want to avoid "Death by Box Plot."*
- **Nitrogen removal.** Why not big differences in nitrogen removal for the sanctuary? A*: Doubling the amount of oysters doesn't double the nitrogen removal.*

C. Discussion and Feedback Regarding the Development of the OysterFutures Modeling Tool

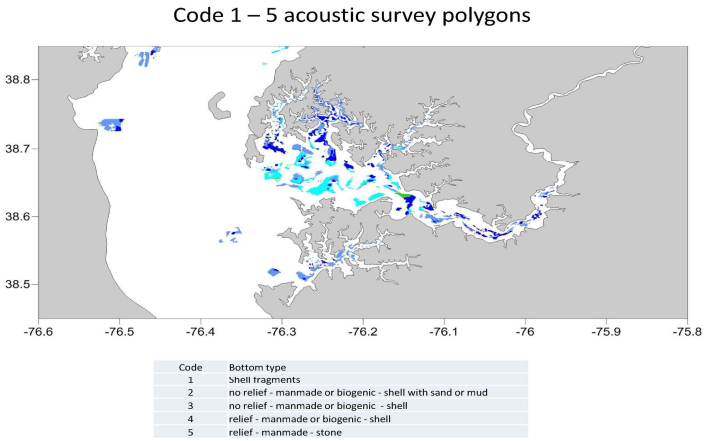
Elizabeth North asked Workgroup members to take a step back and comment on the big picture: i.e. does the modeling appear useful and on the right track? The Workgroup agreed that the challenge is to put all of this into one model and felt it was moving in the right direction with additional fine-tuning regarding shell loss and degradation, recent fishing practices, and the amount of 3-D habitat for other organisms. It should be a valuable tool as the Workgroup considers a series of management options.

D. Larval Transport Model

Elizabeth North noted that the predictions from the Larval Transport Model will be used in the OysterFutures simulation model to forecasts how oyster larvae spawned in one region travel to another. The Larval Transport Model uses predictions of salinity, currents, and turbulence from a hydrodynamic model.



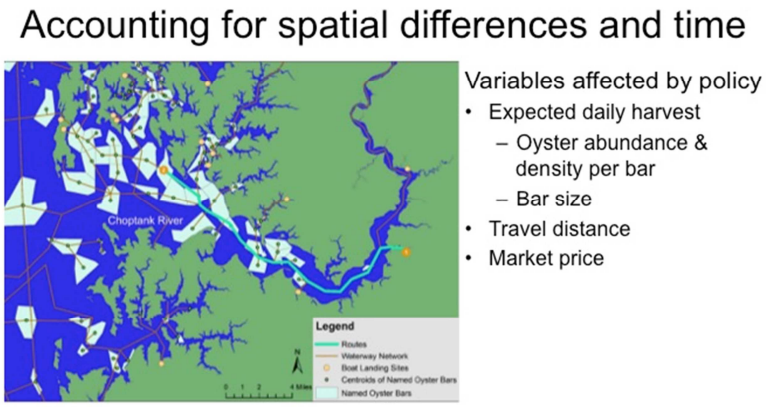
They will use the abundance estimates from the Population model combined with the larval transport model to see if we get the same spat fall patterns as those measured by DNR during the fall survey. She also reviewed the use of the NOAA geo-database which includes maps of different habitat types based on acoustic surveys. The Workgroup members discussed and noted the need for ground trothing and spot checking in areas.



E. OysterFutures Economic Models

Lisa Wanger and Chris Hayes on the Research Team presented their work in developing Economic models to contribute to the overall OysterFutures model.

Chris Hayes presented the preliminary net revenue model to get Workgroup feedback on its assumptions. The Workgroup suggested the need to adjust these estimates to more accurately reflect the real costs, including costs for gear types, distance traveled and not rely on a limited, dated and likely flawed survey conducted in 2006. For example there was no power dredging in Talbot in 2006. Slip fees are too high and license surcharges have gone up fourfold. Chris agreed to redo the survey to get better data to inform the net revenue model.



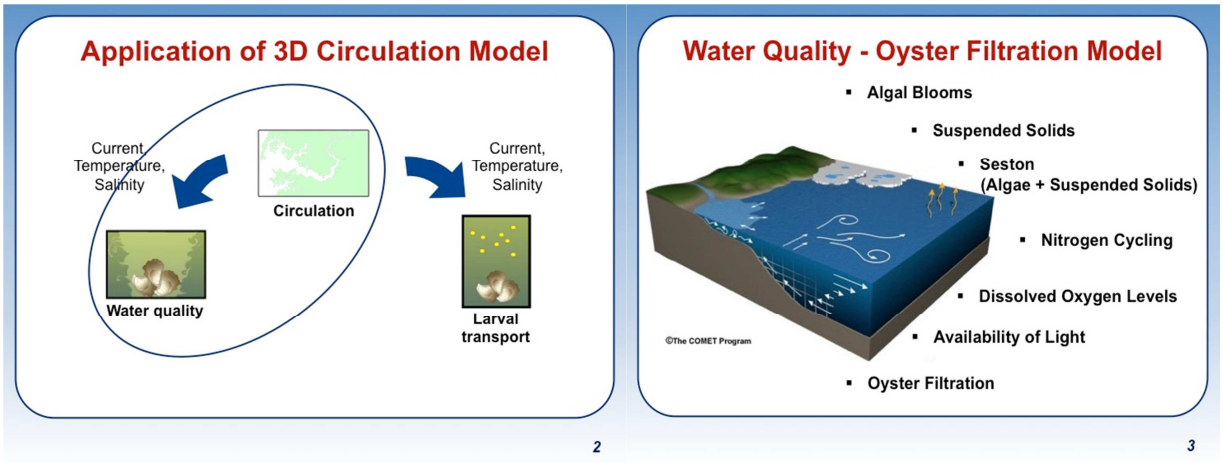
There was discussion of whether the model could value ecosystem service. The researchers noted that, although "value" is very specific to location and it is hard to put accurate values on ecosystem services, the team likely would be able to estimate a value related to nitrogen reduction.

F. Water Quality Modeling

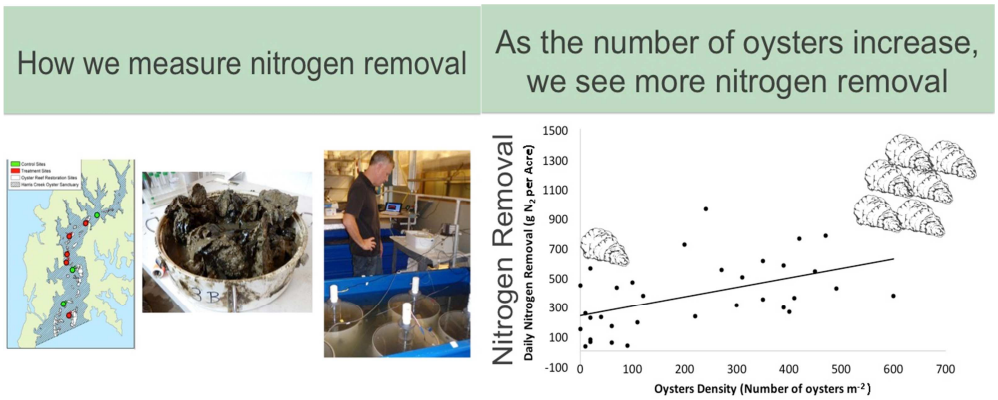
Rasika Gawde presented on the Three Dimensional Water Quality Model applied to the Choptank and Little Choptank Rivers. Raleigh Hood and Elizabeth North have worked with Rasika in conducting this research. The model is designed to calculate how fast algae grows and dies, how seston and other particles move through water, how nitrogen and dissolved oxygen levels change, and how all of these processes respond to oyster filtration.

The researchers plan to use the Three Dimensional Water Quality Model to develop relationships between the number oysters and their influence on light availability in the water column, the amount of seston in the water for each area with different water flows, etc.

Rasika Gawde presented on the Three Dimensional Water Quality Model applied to the Choptank and Little Choptank Rivers. Raleigh Hood and Elizabeth North have worked with Rasika in conducting this research. She noted the oyster filtration model adds biological and chemical processes that represent feeding characteristics and behavior patterns of oysters. The model helps to show how fast algae grows and dies, how seston and how other particles move through water. It tracks nitrogen and dissolved oxygen levels, identifies low oxygen locations, and tracks depth of light and oyster filtration. The model seeks to simulate oysters in their role as ecosystem engineers. The researchers are seeking to develop functional relationships in terms of the impact of oysters on light availability and seston concentrations from the water quality model for each area and reef with different water flows, etc.



Melanie Jackson provided a presentation on nitrogen removal and oyster reef ecosystem services. Nitrogen runoff and pollution fuels algae growth. Without oysters, algae and particles stay in the water column for a long time before settling. Oysters remove algae and solids from the water column and turn them into bio-deposits. Oyster shells and bio-deposits create an ideal environment for nitrogen removal. She noted in summary that oysters store nutrients in their shell, more oysters means more nitrogen removal and hard shells create a better habitat for organisms and nitrogen removal.



Workgroup Comments and Questions:

- **Bio-deposits and worms.** Is nitrogen reduction associated with bio-deposits influenced by worms burrowing into sediment or shell? *A: Yes*
- **Aquaculture gear types.** Are you studying aquaculture gear types and nitrogen removal? *Yes, this Fall we conducted six aquaculture gear type experiments to measure the nitrogen removal under each.*
- This study is important as an accelerator in the aquaculture industry in the coming years.
- **Floating cages.** What about floating cages? *A: Oysters on bottom seem to do more to enhance nitrogen removal. Biodeposits from oysters in floats look like snow, which is fine if spread out with a current but could cause poor water quality if water moves slowly.*
- **Soil chemistry for undisturbed vs. dredged reefs.** Is there research on soil chemistry on bottom on undisturbed vs. dredged reef? *A: No.*

III. INITIAL RESULTS OF MODEL SIMULATED OPTIONS

The Workgroup reviewed and discussed the modeling work and questions for those 9 option areas that had achieved a consensus rating of 75% or greater in the Workgroup's April 2016 meeting. They include:

- Rotational Harvest Options
- Enforcement Options
- Use of Population Assessment in Management Options
- Limited Entry Options
- Habitat Modifications/Restoration Options
- Fee & Tax Option
- Spatial Options
- Regulations Related to Specific Gears Options
- Stocking Options

A. ROTATIONAL HARVEST OPTIONS *(Average Rating: 3.6 of 4, April 2016 Workgroup Rating)*

Consider developing a rotational harvesting strategy that features monitoring and builds upon lessons from other fisheries and addressing questions such as:

- Data collection involving watermen and the state to inform management;
- Criteria to ensure a standing stock for when to open or close an area;
- Strategies to avoid concentration of harvest in few areas;
- Significant changes in management approaches;
- Providing local access for rotational harvest;
- Enforcement and compliance strategies; and
- Investments needed to jump start initiatives.

November 2016 Model Presentation

Mike Wilberg noted the key modeling questions are: what frequency of rotation should be modeled; should it use the Rappahannock River, Virginia approach with a three year rotation in three areas with 2 areas open at any given time? The model has 608 regions represented by polygons, some big and some very small. Should it include individual bars? He noted the modelers could add habitat in the model? How should the model address Sanctuary areas vs. currently harvestable bottoms? How should shell/spat enhancement be conducted?

Workgroup Member Questions and Comments:

- **Treatment of Sanctuary areas in the model.** How do you get this started if you can't go in these sanctuary reserve areas which are closed for 4 more years? We need to get information from the Sanctuary reserve areas in terms of dollars invested and results.
- Modeling rotational harvest in several scenarios uses the status quo regarding sanctuaries, hybrids, etc. *A: The question is where and when since the model has 680 regions. Workgroup need to help to narrow down the targets to make a reasonable set of options.*
- If the Sanctuary areas are not on the table, we won't have enough bottom to work with. Working with a very small area.

- **Addressing the number of licensed watermen.** Rotational options open it up to every oyster licensed watermen in the state? Could 3000 watermen all come to the Choptank River? Where will you put 1000 or 2000 boats on the river? *A: What if we assumed in the model that there were going to be major shell addition efforts in lower Choptank River aimed at restoring those bars. New areas would be included as rotational harvest areas as a starting point?*
- If we have this bottom and opened up to watermen through a rotational harvest it might work. If it is as it is today, what can we do? 600 water men in Talbot county with 300 working the waters.
- **Addressing Federally funded restoration.** If federal funding used to do restoration efforts we have to take it off the table and never open again during a 25 year lease? Quantify/qualify what we can have as rotational harvest. Are Army Corps of Engineer areas eliminated in the model? *A: Yes.*
- Do we assume that oysters in 2 tributaries are on the table except those with federal dollars invested in? Those sanctuary areas where there has been no investment should be on the table. *A: Yes, they can be simulated as open areas in the model.*
- We should propose the remaining Sanctuary areas be targeted towards creating sustainable production of the fishery which is what we are here to achieve. *A: If Sanctuary areas received Army Corps funding, they would be off limits for harvesting in the future. The model tried to set up with something that is realistic and useful including Broadcreek, lower Choptank River and Little Choptank River, upper Choptank areas with no federal funding, middle Choptank and some of Tred Avon, Harris Creek and the mouth of the little Choptank River.*
- **Dividing areas into sections.** Consider spreading out boats into more than 3 areas. Consider divide each area into 3 sections.
- **Is there room for rotation in the public fishery?** There is nowhere for public fishery to rotate. Not enough room. The "best science" took the best bottom.

B. ENFORCEMENT OPTIONS *(Average Rating: 4.0 of 4, April 2016 Workgroup Rating)*

Address and provide funding for enforcement presence on the water (both in increasing numbers and quality through training) to address poaching and support strategies such as focusing on the buyer level.

November 2016 Model Presentation
Mike Wilberg noted the model incorporates harvest of undersized oysters. He asked the Workgroup to what degree they want to focus on harvesting in closed areas in the model.

Workgroup Member Questions and Comments:
- **Illegal harvest** is of concern, but how do we quantify it?
- **How do we model better enforcement?** Is there better oyster survival because people are not taking undersized ones? We are underselling the benefits of better enforcement. Better enforcement might produce X+ survival. *A: We want to be able to look at changes harvest patterns. How it will oysters respond to different enforcement actions, e.g. more officers measuring at dealers to reduce undersized harvest, or more officers on the water, etc.?*
- **Use of monitoring seed data.** There is extensive data on seed put down and monitoring survival rates. We should have a good idea of how many 3-year olds should be in various areas based on the 2012 spat set. Look at monitoring to see how many are

not there and then use that information as a measure of disease and poaching? *A: This is very hard to do. Sampling population in 3 years will have holes. May not be able to assume impact of poaching if observed values different. Recommend talking with NOAA sanctuary divers regarding their expert judgment on illegal dredging.*

- Note that the divers tend to avoid sites because they are disturbed.
- **Underwater drone surveillance.** Can we consider underwater drone/surveillance system (vs. divers) and SONAR monitoring in areas we know are being impacted?
- **Oysters planted on rock.** In Harris creek the NRP has been underfunded. We have an advance radar system protecting showcase locations. Let's wait and see what data tells us. The Oyster Advisory Commission (OAC) is seeking information on the results of the 3-year monitoring, especially on the site planted on rock.
- **Physical deterrent** is another element to enforcement.

C. USE OF ASSESSMENT OF POPULATION IN MANAGEMENT OPTIONS *(Average Rating: 4.0 of 4, April 2016 Workgroup Rating)*

Conduct a stock assessment of the oyster resource/fishery with involvement of the stakeholders.

Michael Wilberg noted this was subject to legislation and that he has been asked by DNR to help with the legislatively directed oyster stock assessment.

Workgroup Member Questions and Comments:

- *None*

D. LIMITED ENTRY OPTIONS *(Average Rating: 3.9 of 4, April 2016 Workgroup Rating)*

1. Consider limiting entry to oyster fishery to watermen making the majority of their living from commercial fishing. *(Average Rating: 3.9 of 4, April 2016 Workgroup Rating)*
2. Create a limited entry oyster fishery. *(Average Rating: 3.75 of 4, April 2016 Workgroup Rating)*

November 2016 Model Presentation

Mike Wilberg highlighted some key questions for modeling that include: where should the number of licenses be? Should it be income-based, harvest based? What years do you pick? Of 5000 DNR licenses, 3000 are TFL umbrella license holders and of those about 500-800 are oyster licenses. It is capped at about 3800. Watermen can only harvest if they pay an oyster surcharge.

Workgroup Member Questions and Comments:

- **Full vs. Part time watermen.** If there is data to separate full time vs. part time it would be important to figure in.
- **Limiting entry to the fishery.** DNR tried to reduce the number of the people in the fishery and it caused an uproar among watermen. Part time vs. full time may not go over well. Limiting the fishery for part time and full time will not be the answer. *A: Virginia is*

reducing license through attrition and 20 days fishing. Jim Wesson made a presentation at the OysterFutures Symposium.

- In 1994 DNR created a limited entry and moratorium cutting off the sale of licenses.
- Limited entry options will be challenged. The fishery won't be able to support 3800 again. Out of 1100 with licenses. A third don't participate but hold the license and pay the surcharge in case they can get a future piece of the pie.
- It is critical that we figure out the number of limited participation or we are wasting our time.
- We are looking for a fair way to limit entry.
- **Declining opportunities for watermen.** There is not enough to make a living for the 3800 license holders. Approximately 1100 watermen last year. There will be less oysters and watermen out there this year.
- **Test scenarios with the model.** This is an opportunity to test scenarios, e.g. full time and part time, maybe the model can show that limits can increase if there are fewer fisherman.
- **Surcharges.** We need a starting point and then worry about buyouts and reductions. A $300 surcharge should be high on the list. This will be the future vs. a complete moratorium.
- We have to cap our effort. Figure out the surcharge numbers over the last 3 years. Look at lowest rate of participation. Somewhere in the middle will be a sustainable number. Target that as goal then move towards that goal with a criteria program. Any Workgroup recommendation needs to be supported by the watermen.
- **Use or lose license scenario**. As a starting point, pay the surcharge and then use it or lose it? How many days would be required for participation? We still have up to ½ that have the potential to get entry that aren't currently participating. Would need to double the harvest to accommodate.
- **Establishing the number of watermen and harvest levels.** Of the 1100 watermen, 749 harvest over 100 bushels. 400 harvest 100 bushels or less.
- **Consider an oyster only license.** TFL holders may take out fishing vs. oyster licenses and choose to fish vs. oyster. Consider cutting down on the oyster license.
- **Drug testing.** Consider drug testing in license holders. Knock out of problem areas.
- 85% of surcharge holders actually harvest oyster. Couple year old data.
- **License impact on families.** May have to look at changing the rules that allow leasing out of held licenses. That will impact surcharges. Multiple license holders hold 900 pot licenses.
- **Impact on younger watermen.** Need to create a path for younger watermen to get in and stay in business. This is a complex issue and we shouldn't discourage them.
- Without creating a sustainable industry, the younger watermen won't come any way. Our priority should be to sustain the fishery first then rebuild the industry economy that is stable and viable.
- **Limit license and increase it value.** Could we put a limit on the number of licenses and make the remaining ones more valuable? Then people can sell their license to retire.
- A non-license person could still participate. License the boat for hand tongs. There should be ways for people to participate to work their way up.

- **Increase oyster population first.** Unless we find a way to increase the oyster population, it will defeat the purposes of interests around the table. We are all about increasing the population.

E. HABITAT MODIFICATION/RESTORATION OPTIONS (3)

1. Focus on strategies for increasing the funding, use and reclamation of local shells from the Chesapeake Bay and from local watermen to supplement bars and increase the viability of the oyster resource. *(Average Rating: 4.0 of 4, April 2016 Workgroup Rating)*
2. Increase productivity of existing bottoms by improving habitat and structure. Increase the potential productivity per acre of existing bottoms by smartly managing them and doing it right. *(Average Rating: 3.9 of 4, April 2016 Workgroup Rating)*
3. Develop a strategy that tests the effectiveness of strategically placed 3-dimensional bottoms with artificial reefs and alternative substrates. [*(Average Rating: 3.9 of 4, April 2016 Workgroup Rating)*

November 2016 Model Presentation
Mike Wilberg asked if there were specific locations that might work for testing? Otherwise the model will focus on areas with information about water quality and habitat.

Workgroup Member Questions and Comments:
- **Artificial reefs.** What about artificial reefs? There are permitting issues and differing opinions. In creating new habitat with new benefits we should avoid conflicts with crabbers, clammers and natural oyster bars. It should be up to the industry to say where.
- **Sediment changes.** How can the model account for sediment changes? *A: We discussed that earlier. We don't have a great way to model when a specific fraction of the shell is lost each year in specific places (from previous study). The model assumes similar processes in terms of changes based on the averages between 1980-2008.*
- **Model for storms.** Hurricane Agnes badly impacted the main stem but affected mostly fish. Will major storms be in the model? *A: Yes*
- **Man-made habitat adjacent to natural oyster bars.** Direction should be around manmade habitat alongside natural bars. Bring entire industry and stakeholders into the effort to enhance harvest and larval production. Provide some quick take opportunities on bars build the infrastructure of an industry focused on growing the product. It is all about the economics and we need to get the engine running.
- **Lower Choptank River.** In the lower Choptank River, investments are trying to capture the larvae from current sanctuaries.
- **Level of funding for sustainability.** Is there any way to determine how much funding would make the oyster fishery sustainable? *A: How much it costs is a performance measure. Costs of fresh shell and fossil shell can be included.*
- **Loss of shell.** Is loss of shell included in model? *A: Yes.*

F. FEE & TAX OPTION *(Average Rating: 3.9 of 4, April 2016 Workgroup Rating)*

Evaluate and consider changes/increases of oyster fishery related fees and taxes.

November 2016 Model Presentation
Mike Wilberg noted that this option has been covered in terms of limited entry. In terms of specific options, he noted the model could test the impact of doubling the bushel tax and the oyster surcharge.

Workgroup Member Questions and Comments:

- **Limited entry to public areas.** It is a problem if we limit entry to publicly funded areas. Doubling the cost of the surcharge defeats the purpose. We should raise the public funds to support these ideas.
- The rationale for public funds is to get industry back on its feet. Consider doubling one and eliminating the other.
- Consider the degree to which that impacts accurate reporting.
- **Eliminate bushel tax.** Might include eliminating bushel tax.
- **USDA aquaculture funding.** USDA has been developing an effort to recognize aquaculture as a farming practice and there may be a potential new source of funding for oyster restoration.
- **Oyster tax.** Consider an oyster tax of $1 on a bushel as an export tax. That is shell and material you are not getting back that is worth more than the export tax. Worth more in the state than an export.
- **Increase export tax vs. bushel tax.** Increase the export tax vs. bushel tax. Currently it could be a win-win.
- The Governor has indicated he won't increase fees or taxes.
- All taxes/fees will come back to watermen and come out of our profits.
- **License surcharge.** The price of the license/surcharge is one way of creating limited entry.
- **Eliminate the bushel tax and double the surcharge**. Discourage people from holding on the license without participating.
- **More bottom habitat.** Since we gave up 24% to the Sanctuary, we should figure out a way to receive 24% of spat on shells produced here to enhance the bars that are non productive and create more bottom habitat. This will create opportunities for rotation by increasing our bottom.

G. SPATIAL OPTIONS (4)

1. Consider modifying regulations so a single bar is not divided between gear types or open and closed. [Theme A—Average Rating: 3.9]
2. Modify the shapes of sanctuaries so that whole tributaries are not closed. [Theme A—Average Rating: 3.6]
3. In restoring tributaries provide limited access to the fishery that can allow fishermen the opportunity to work on that river while the restoration plan is developed. [Theme D—Average Rating: 3.6]
4. Continue the Sanctuary program with some modification that may include providing for maintenance including the potential for limited harvest in tributaries and assessing the state of oyster bars within sanctuaries. [Theme D—Average Rating: 3.4]

November 2016 Model Presentation

Mike Wilberg noted we already talked about locations where management or restoration efforts take place. What activities are allowed or not?

Workgroup Member Questions and Comments:
November 2016 Model Presentation

- **Loss of Sanctuary bottom.** Shocked about the loss of sanctuary bottom. We should spend and target money on areas that lost the most workable bottom.
- **Prioritizing funding** to areas that were lost. Choptank River hand tongers lost the most workable bars. Make investment in that area first. A*: We can do that in the model by focusing restoration in hand tong areas. Wouldn't model statewide effort to fund.*
- **Encourage Less Destructive Gear.** Provide more opportunity for less destructive gears. Hand tong more productive because shell more gently preserved. Have to consider the impact of dredge on spat mortality. We should prioritize by gear type.
- **GIS Reporting Technology.** Consider GIS technology which is available for reporting, e.g. chips that plug into the boat.
- **Sanctuaries on the Dorchester side**. For the sanctuaries on the Dorchester side, there is no Federal investment in the region. In the main stem Choptank, gear type impacts harvest. Depth and wind are issues there for hand tongers.

H. REGULATIONS RELATED TO SPECIFIC GEARS OPTIONS *(Average Rating: 3.9 of 4, April 2016 Workgroup Rating)*

Conduct more and better research to inform regulations and better understand the efficiency of gear types and their impacts on the fishery.

November 2016 Model Presentation
Mike Wilberg already talked about locations where management or restoration efforts take place. If areas in sanctuary are open in a model scenario, should it be for hand tong only?

Workgroup Member Questions and Comments:

- **Areas and gear types.** Based on area-model we should take into consideration different gear types for different areas. *A: There are currently 5 gear types in the model.*
- **Mortality data for gear types.** Do we have mortality data for power dredging and hand tonging now? *A: Yes*

I. STOCKING OPTIONS *(Average Rating: 3.9 of 4, April 2016 Workgroup Rating)*

Focus on strategies for increasing the funding for the use of Spat on shells everywhere not just in a few places.

November 2016 Model Presentation
Mike Wilberg indicated the key modeling questions are where to stock and how often and how much. Should we model differences in how spat survive and grow on shell or chip?

Workgroup Member Questions and Comments:

- **Alternatives to spat on shell.** We should look at other applications in addition to spat on shell such as larvae on chips. We should allow biding based on new products along with spat on shell. This approach as zero impact on shells.
- **Rebuild habitat first.** We should rebuild habitat first.
- **Federal funding for aquaculture.** We should seek federal funding for aquaculture that can benefit to keep wild fishery functioning.

V. NEXT STEPS

A. Workgroup Schedule

The modelers noted that a realistic assessment of when an operational model with habitat, fishing effort and economics having the full spatial scale of all the regions would be ready for stakeholder use in March 2017. The Workgroup discussed whether to leave the Little Choptank River out of the model and meet in February to review the other areas, and decided it was important to include the Little Choptank and therefore meet in March.

They discussed ecological interconnection of the various areas and agreed to reschedule the January 2017 meeting and meet on March 24-25, 2017. This would allow inclusion of the Little Choptank River in the model and bring everyone to the table to review model and the schedule going forward. Following the March meeting the schedule calls for two more meetings in May and July to reach agreement on the Workgroup recommendations to DNR. The facilitator noted the critical importance of participation of all stakeholders going forward to make the most of the process.

B. Communication Strategy Update

Elizabeth North noted that videos from the OysterFutures Symposium in St. Michaels should be on YouTube before Christmas. She said much was learned from the symposium and the exit surveys indicated very high scores for the Symposium with the panels and Q & A dialogue rating the highest.

Elizabeth North noted the importance of the OysterFutures communication strategy in getting word out on the options under consideration to the broader watermen community. There was discussion of whether to convene any workshops on the Workgroup's recommendations prior to submitting to DNR in the summer such as public workshops in each county. It was agreed to discuss this and make a decision at the March meeting. There was also discussion of how the output from OysterFutures connects with the Oyster Advisory Commission. It was agreed that the Workgroup needed to get further down the road in its work (following the May 2017 meeting) before connecting with the OAC.

At the conclusion of the meeting the Workgroup members went around the table to offer comments on the meeting and completed meeting evaluations *(see Appendix #3)*

Appendix #1 Workgroup Meeting III Agenda

OYSTERFUTURES WORKGROUP
MEETING III
SATURDAY – SUNDAY, NOVEMBER 5 - 6, 2016
Horn Point Laboratory—AREL Conference Room
2020 Horns Point Road—Cambridge, Maryland

WORKGROUP MEETING OBJECTIVES		
✓ To Approve Agenda and Meeting II Summary Report ✓ To Review OysterFutures Project Goal Statement ✓ To Receive Update, Discuss and Provide Feedback Regarding Development of the OysterFutures Modeling Tool ✓ To Receive OysterFutures Model Demonstration and Example Results of Simulated Options ✓ To Review Current Options and Performance Measures ✓ To Determine Whether Revisions or Additional Options and/or Performance Measures are Needed ✓ To Identify Needed Next Steps, Information Needs, and Agenda Items for Next Meeting		
MEETING AGENDA DAY ONE—SATURDAY, NOVEMBER 5, 2016		
All Agenda Times—Including Adjournment—Are Approximate and Subject to Change		
2:00 PM		***LATE LUNCH AND SOCIAL SCIENCE STUDY SURVEY (ON CAMPUS)***
1.)	**2:30 PM**	**WELCOME AND INTRODUCTIONS**
2.)	**2:40 PM**	**AGENDA REVIEW AND APPROVAL (November 5 – 6, 2016)**
3.)	**2:45 PM**	**APPROVAL OF FACILITATOR'S SUMMARY REPORT (April 30 – May 1, 2016)**
4.)	**2:50 PM**	**OYSTERFUTURES PROJECT GOAL REVIEW**
5.)	**3:00 PM**	**UPDATE ON THE DEVELOPMENT OF THE OYSTERFUTURES MODELING TOOL [Population and Fishery Dynamics Model, Economics Model, and Water Quality Model]**
~4:00 PM		***BREAK***
6.)	**4:20 PM**	**OVERVIEW OF MODEL DEMONSTRATION AND METHOD FOR PRESENTATION OF MODEL SIMULATIONS**
7.)	**5:00 PM**	**DISCUSSION AND FEEDBACK REGARDING THE DEVELOPMENT OF THE OYSTERFUTURES MODELING TOOL [Population and Fishery Dynamics Model, Economics Model, and Water Quality Model]**
8.)	**6:25 PM**	**SUMMARY OF DAY ONE AND REVIEW OF DAY TWO AGENDA**
9.)	***~6:30 PM***	***RECESS AND INFORMAL SOCIAL WITH DINNER (ON CAMPUS)***
MEETING AGENDA DAY TWO—SUNDAY, NOVEMBER 6, 2016		
All Agenda Times—Including Adjournment—Are Approximate and Subject to Change		
10.)	**9:00 AM**	**WELCOME**
11.)	**9:05 AM**	**DISCUSSION AND FEEDBACK REGARDING THE DEVELOPMENT OF THE OYSTERFUTURES MODELING TOOL—CONTINUED AS NEEDED BASED ON DAY ONE RESULTS**
~10:00 AM		***BREAK***
12.)	**10:20 AM**	**OVERVIEW OF METHODS FOR PRESENTATION, AND EXAMPLE RESULTS OF MODEL SIMULATED OPTIONS AND DISCUSSION**
~12:00 PM		***LUNCH (ON CAMPUS)***
	12:30 PM	**EXAMPLE RESULTS OF MODEL SIMULATED OPTIONS AND DISCUSSION—CONTINUED**
~2:00 PM		***BREAK***
13.)	**2:20 PM**	**REVIEW AND REVISION OF EXISTING OPTIONS AND PERFORMANCE MEASURES**
14.)	**3:45 PM**	**DISCUSSION REGARDING WHETHER ADDITIONAL OPTIONS AND/OR PERFORMANCE MEASURES ARE NEEDED**
15.)	**4:30 PM**	**UPDATE ON COMMUNICATION STRATEGY AND ACTIONS FOR THE PROJECT**
16.)	**4:45 PM**	**NEXT STEPS: AGENDA ITEMS AND INFORMATION FOR THE NEXT MEETING** • Review action items and assignments & Identify agenda items and any needed information for next meeting
17.)	***~5:00PM***	***ADJOURN***

Appendix #2 Workgroup & Research Team Membership
(Bold= participating, *Italics*= absent)

MEMBER	AFFILIATION
WATERMAN	
Billy Abey	East New Market, MD
J.D. Buchanan	Preston, MD
Geoff Harrison	TWA, Tilghman, MD
Gregory Kemp	McDaniel, MD
Logan Rippons	Cambridge, MD
Scott Todd/Cody Paul	Woolford, MD
AQUACULTURE	
Bobby Leonard	Tred Avon Treats, Ruff-N-Ready, LLC.
Johnny Shockley	Hoopers Island Oyster Aquaculture Co.
SEAFOOD BUYERS	
Aubrey Vincent	Lindy's Seafood
ENVIRONMENTAL CITIZEN GROUPS	
Kelly Cox	Phillips Wharf Environmental Center
Bill Goldsborough	Chesapeake Bay Foundation
Mark Bryer/ **Joe Feher**	The Nature Conservancy
RECREATIONAL FISHING GROUP	
David Sikorski	Coastal Conservation Association (CCA)
MARYLAND DEPARTMENT OF NATURAL RESOURCES	
Dave Blazer/Chris Judy	Maryland Department of Natural Resources
OYSTER RECOVERY PARTNERSHIP	
Ward Slacum	Oyster Recovery Partnership
FEDERAL AGENCY	
Stephanie Westby	National Oceanic and Atmospheric Administration (NOAA)
PROJECT SCIENTISTS AND FACILITATORS	
NAME	**AFFILIATION**
UNIVERSITY OF MARYLAND CENTER FOR ENVIRONMENTAL SCIENCE	
Elizabeth North	Fisheries Scientist
Jeffery Cornwell	Estuarine Biogeochemist
Chris Hayes	Economist
Raleigh Hood	Biological Oceanographer
Thomas Miller	Fisheries Ecologist
Lisa Wainger	Environmental Economist (Social Scientist)
Michael Wilberg	Fisheries Scientist
Melanie Jackson	
Rasika Gawde	
VIRGINIA INSTITUTE OF MARINE SCIENCE	
Troy Hartley	Environmental and Natural Resource Policy (Social Scientist)
Taylor Goelz	Graduate student
Jennifer Beckersteiner	Student
FCRC CONSENSUS CENTER, FLORIDA STATE UNIVERSITY	
Jeff Blair	Workgroup Facilitator
Robert Jones	Workgroup Facilitator

WORKGROUP MEMBERSHIP PARTICIPATION- SATURDAY	
MEMBER	**AFFILIATION**
WATERMAN	
Billy Abey	East New Market, MD
J.D. Buchanan	**Preston, MD**
Jeff Harrison	**Tilghman, MD, Talbot County Commercial Oyster Committee Chair**
Gregory Kemp	McDaniel, MD, Vice President of Talbot Waterman's Association
Cody Paul	Church Creek, MD, Dorchester County Commercial Oyster Committee Chair
Logan Rippons	Cambridge, MD
AQUACULTURE	
Bobby Leonard	**Tred Avon Treats, Ruff-N-Ready, LLC.**
Johnny Shockley	Hoopers Island Oyster Aquaculture Co.
SEAFOOD BUYERS	
Aubrey Vincent	**Lindy's Seafood**
ENVIRONMENTAL CITIZEN GROUPS	
Kelly Cox	Phillips Wharf Environmental Center
Bill Goldsborough	**Chesapeake Bay Foundation**
Joe Fehrer	**The Nature Conservancy**
RECREATIONAL FISHING GROUP	
David Sikorski (Sunday)	Coastal Conservation Association (CCA)
MARYLAND DEPARTMENT OF NATURAL RESOURCES	
Dave Blazer **Chris Judy**	Maryland Department of Natural Resources
OYSTER RECOVERY PARTNERSHIP	
Ward Slacum	Oyster Recovery Partnership
FEDERAL AGENCY	
Stephanie Westby	National Oceanic and Atmospheric Administration (NOAA)

PROJECT SCIENTISTS AND FACILITATORS- SATURDAY	
NAME	**AFFILIATION**
UNIVERSITY OF MARYLAND CENTER FOR ENVIRONMENTAL SCIENCE	
Elizabeth North	Fisheries Scientist
Jeffery Cornwell	Estuarine Biogeochemist
Raleigh Hood	Biological Oceanographer
Thomas Miller	Fisheries Ecologist
Lisa Wainger	Environmental Economist (Social Scientist)
Michael Wilberg	Fisheries Scientist
VIRGINIA INSTITUTE OF MARINE SCIENCE	
Troy Hartley	Environmental and Natural Resource Policy (Social Scientist)
FCRC CONSENSUS CENTER, FLORIDA STATE UNIVERSITY	
Jeff Blair	Workgroup Facilitator
Robert Jones	Workgroup Facilitator

WORKGROUP MEMBERSHIP PARTICIPATION SUNDAY

MEMBER	AFFILIATION
WATERMAN	
Billy Abey	East New Market, MD
J.D. Buchanan	**Preston, MD**
Jeff Harrison	**Tilghman, MD, Talbot County Commercial Oyster Committee Chair**
Gregory Kemp	McDaniel, MD, Vice President of Talbot Waterman's Association
Cody Paul	Church Creek, MD, Dorchester County Commercial Oyster Committee Chair
Logan Rippons	Cambridge, MD
AQUACULTURE	
Bobby Leonard **MJ Dubois**	**Tred Avon Treats, Ruff-N-Ready, LLC.**
Johnny Shockley	Hoopers Island Oyster Aquaculture Co.
SEAFOOD BUYERS	
Aubrey Vincent	**Lindy's Seafood**
ENVIRONMENTAL CITIZEN GROUPS	
Kelly Cox	Phillips Wharf Environmental Center
Bill Goldsborough	**Chesapeake Bay Foundation**
Joe Fehrer	**The Nature Conservancy**
RECREATIONAL FISHING GROUP	
David Sikorski *(Sunday)*	Coastal Conservation Association (CCA)
MARYLAND DEPARTMENT OF NATURAL RESOURCES	
Dave Blazer **Chris Judy**	Maryland Department of Natural Resources
OYSTER RECOVERY PARTNERSHIP	
Ward Slacum	Oyster Recovery Partnership
FEDERAL AGENCY	
Stephanie Westby	National Oceanic and Atmospheric Administration (NOAA)

PROJECT SCIENTISTS AND FACILITATORS- SUNDAY	
NAME	**AFFILIATION**
UNIVERSITY OF MARYLAND CENTER FOR ENVIRONMENTAL SCIENCE	
Elizabeth North	Fisheries Scientist
Jeffery Cornwell	Estuarine Biogeochemist
Raleigh Hood	Biological Oceanographer
Thomas Miller	Fisheries Ecologist
Lisa Wainger	Environmental Economist (Social Scientist)
Michael Wilberg	Fisheries Scientist
VIRGINIA INSTITUTE OF MARINE SCIENCE	
Troy Hartley	Environmental and Natural Resource Policy (Social Scientist)
FCRC CONSENSUS CENTER, FLORIDA STATE UNIVERSITY	
Jeff Blair	Workgroup Facilitator
Robert Jones	Workgroup Facilitator

Appendix #3 OysterFutures Workgroup Meeting Evaluation Summary

OYSTERFUTURES WORKGROUP
NOVEMBER 5-6, 2016—CAMBRIDGE, MARYLAND
MEETING EVALUATION SUMMARY

Members used a 0 to 10 rating scale where a 0 meant Totally Disagree and a 10 meant Totally Agree. The average ratings from 13 evaluation forms that were received are indicated below:

1. Please assess the overall meeting.

8.0 The background information was very useful.
8.7 The agenda packet was very useful.
8.7 The objectives for the meeting were stated at the outset.
8.8 Overall, the objectives of the meeting were fully achieved.

2. Do you agree that each of the following meeting objectives was achieved?

8.3 Update and feedback regarding development of the OysterFutures modeling tool.
8.4 OysterFutures model demonstration and example results of simulated options
8.4 Review and discussion of current options and performance measures
8.0 Discussion and identification of any additional options and/or performance measures
8.7 Review of Next Steps and Agenda Items for Next Meeting.

3. Please tell us how well the Facilitator helped the participants engage in the meeting.

8.8 The members followed the direction of the Facilitator.
9.3 The Facilitator made sure the concerns of all members were heard.
9.5 The Facilitator helped us arrange our time well.
8.9 Participant input was documented accurately in the April Facilitator's Summary.

4. Please tell us your level of satisfaction with the meeting?

9.0 Overall, I am very satisfied with the meeting.
9.0 I was very satisfied with the services provided by the Facilitator.
8.4 I am satisfied with the outcome of the meeting.

5. Please tell us how well the next steps were communicated?

8.1 I know what the next steps following this meeting will be.
8.0 I know who is responsible for the next steps.

6. What did you like best about the meeting?

- Excellent discussions- very open and thoughtful and constructive. Good Presentations and explanation of the models.
- The continued dialogue
- Information presented and the conversation
- Open discussion
- Conversation

- The civil back and forth between different stakeholders
- Best discussion was during the identification of options and performance measures.
- Well arranged, we were able to cover a lot.
- The level of effort to make sure everyone's opinion is heard and respected.
- Great discussions, I can see consensus building and relationships growing.

7. How could the meeting have been improved?

- Making sure we get full workgroup attendance.
- In the beginning of the meeting it would be helpful to clarify what the panel should expect as next steps. I think it was unclear how decisions and ideas during the workgroup discussions would be incorporated into the next steps.
- Find more/continued watermen involvement. How?
- Full attendance
- Everyone shows up.
- Having the material earlier to review
- Faster

8. Do you have any other comments?

- Thank you for inviting me to participate in this project.

Appendix #4 OysterFutures Workgroup Purpose and Project Summary

STATEMENT OF PURPOSE. The goal of OysterFutures is to develop recommendations for oyster policies and management that meet the needs of industry, citizen, and government stakeholders in the Choptank and Little Choptank Rivers.

With funding from the National Science Foundation, we will hold a series of workgroup meetings with a representative group of stakeholders. Through these meetings, the stakeholders will produce a collective vision for the future of oysters in this region and build consensus on policy and regulatory options which will be informed by stakeholder and scientific knowledge and by the joint development and use of a modeling tool. The Maryland Department of Natural Resources has agreed to evaluate the consensus recommendations that result.

The stakeholders participating on the workgroup will be representatives from the key interest groups that affect and are affected by the oyster fishery. Researchers from the University of Maryland Center for Environmental Science and the Virginia Institute of Marine Science will serve as consultants to the stakeholders. Professional independent facilitators with experience in fisheries issues will convene the stakeholder meetings. The facilitators will ensure that a consensus-based approach which includes the input of diverse stakeholders is used to develop the collective vision and recommended actions for a sustainable and profitable future for the oyster industry in the Choptank and Little Choptank Rivers.

PROJECT SUMMARY. Achieving effective natural resource management is challenging because of the multiple and often competing objectives of different stakeholder groups, a limited set of policy options, and uncertainty in the performance of those options. Yet, managers need policies that allow continued use of natural resources while ensuring access for future generations and maintenance of ecosystem services. Formal approaches are needed that will assist managers and stakeholders in choosing policy options that have a high likelihood of achieving social, ecological, and economic goals. The goal of this project, OysterFutures, is to address this need by improving the use of predictive models to support sustainable natural resource policy and management. A stakeholder-centered process will be used to build an integrated model that combines estuarine physics, oyster life history, and the ecosystem services that oysters provide (e.g., harvest, water quality) to forecast outcomes under alternative management strategies. Through a series of facilitated meetings, stakeholders will participate in a science-based collaborative process which will allow them to project how well policies are expected to meet their objectives using the integrated model. This iterative process will ensure that the model will incorporate the complex human uses of the ecosystem as well as focus on the outcomes most important to the stakeholders. In addition, a study of the socioeconomic drivers of stakeholder involvement, information flow, use and influence, and policy formation will be undertaken to improve the process, enhance implementation success of recommended policies, and provide new ideas for integrating natural and social sciences, and scientists, in sustainable resource management. In this presentation, the strategy for integrating natural system models, stakeholder views, and sociological studies as well as methods for selecting stakeholders and facilitating stakeholder meetings will be described and discussed.