APNEP Scientific and Technical Advisory Committee

North Carolina Department of Environment & Natural Resources Regional Office

943 Washington Square Mall, Washington, North Carolina 27889

Winter Meeting Notes, January 27, 2011

STAC Members Present: Larry Baldwin, Brian Boutin, Peter Caldwell, Tom Crawford, Robin Dennis, Erin Fleckenstein, Joel Fodrie, Joe Fridgen, Kirk Havens, David Kimmel, Wilson Laney, Mike Piehler, Enrique Reyes, Tim Spruill, Don Stanley, Toddi Steelman, Dorsey Worthy

Agency Science & Technology Liaisons: Kevin Hart (NC-DMF), Jon Blanchard (NC-DPR), David Jones (NC-DFR for Bill Swartley), Jill Paxson (NC-DWQ for Bryn Tracy)

Guests & Invited Speakers: Anne Hoos (USGS), Roxolana Kashuba (USGS), Lindsay Dubbs (UNC-CH-IMS), Rhonda Evans (USEPA-Region 4)

Staff Present: Dean Carpenter, Jimmy Johnson, Scott Gentry, Todd Herbert

Call to Order: Wilson Laney welcomed everyone at 10:10 AM.

Appreciations were made and a moment of silence was observed in memory of STAC colleague Dr. Mark Brinson. Prior to the winter STAC meeting, a letter of condolences was sent to Mark's family on behalf of the APNEP family.

Wilson asked if there were any comments or changes to the notes from the fall meeting (November 2, 2010). Minutes were approved by consensus with no changes. There were no members of the public present to offer comments.

APNEP Update: Dean Carpenter

- Dean thanked everyone for attending. He recognized Rhonda Evans, who serves as the EPA regional liaison to APNEP, and he thanked our state agency liaisons for attending the meeting. He noted that the STAC does not state agency representatives on the STAC, per se, to maintain the scientific independence of the STAC.
- Two new members of the STAC are attending their first meeting: Pete Caldwell from NCSU and Erin Fleckenstein with the North Carolina Coastal Federation.
- Jim Hawhee, APNEP Community Specialist, is leading a major upgrade to the entire program website, including working with Dean on the science and technology area. All STAC member biographies are posted on the site. Members are encouraged to visit the site and make comments or suggestions.
- STAC spring and summer meetings have been scheduled. The spring meeting will be held Wednesday, April 27, and the summer meeting will be Tuesday, July 26. Both of these meetings will be at the Pitt County Office Complex in Greenville.
- In November Dean provided written comments to the EPA on their draft Albemarle-Pamlico Watershed & Estuary Study Plan. Several STAC members, including Mark Brinson, also provided comments to the EPA.
- Also in November, the Association of National Estuary Programs (ANEP) Fall 2010 Meeting was held at Charlotte Harbor in Punta Gorda, Florida. APNEP staff (Bill Crowell, Dean Carpenter, Jim Hawhee, Scott Gentry) were in attendance. Dean gave a presentation on the ecosystem-based management approach that APNEP is taking with the update of the CCMP.

- Dean met with several people in November, including Ryan Boyles at the NC State Climate Office, to discuss climate planning and the assessment of climate indicators. In December Dean attended the eastern NC Hydrilla Symposium. Dean met with Tim to discuss assessment reporting measures for aquatic indicators. Dean and Wilson met in January to work on the STAC Action Plan, and this will soon be finalized with the STAC Executive Board and posted it to the web site. Last Monday Dean met with the CHPP Steering Committee. The APNEP terrestrial resources monitoring & assessment team met on January 19.
- The APNEP Policy Board is meeting on February 3 in Greenville. Wilson Laney and Kirk Havens will represent the STAC at this meeting.
- Scott Gentry noted that APENP advertised two Requests for Proposals (RFP) since the fall STAC meeting. The Citizens' Advisory Committee selected four projects for a "Local Project Grant" for environmental enhancement and demonstration projects. An "Estuary Education and Awareness Campaign" was also advertised. Three public outreach projects were selected by the Policy Board's executive subcommittee, out of 19 proposals submitted. There was a total $600,000 requested for the $50,000 in available funding.
- There was no public comment to these announcements.

Assessing Water Quality by Application of a Regional Regression Model of Nitrogen Transport: Ann Hoos **note: presentations can be found in their entirety on the STAC website.*

- Anne Hoos is a hydrologist with the U.S. Geological Survey's (USGS')National Water Quality Assessment Program. Ann presented results and insights from application of the **SPA**tially **R**eferenced **R**egressions **O**n **W**atershed (SPARROW) model. Her presentation included lessons learned for future applications of empirical models to the Albemarle-Pamlico Region.
- The National Water Quality Assessment Program (NAWQA) conducts status and trends analyses of nutrients in streams and rivers. NAWQA is divided into eight regions across the United States, with the APNEP study area located in the (southeast) Region 2. The objective of these regional studies is to build understanding of how human activities and natural features influence nutrient conditions in streams and support resource decisions.
- To use SPARROW, the modeler begins with monitoring data and estimates of mean annual load (in this case nitrogen). Next, a regression analysis explains the pattern of monitored loads as a function of loading and factors controlling movement across the land (land cover) to the stream. The model simplifies all the processes into a single function. It looks at in-stream transport and decay and tracks these different sources.
- To calibrate the model, monitoring data was combined from state, federal, and in some cases, local agencies.
- Five significant sources of nitrogen have been identified by SPARROW: atmospheric deposition (47%); fertilizer applied to farmland (20%); animal waste (13%); point sources discharge (11%); and urban land (9%). The percentages were noted to be average values. The model is an 11-variable regression, with an average prediction error of plus/minus 35 percent.
- The model is documented in a peer-reviewed publication and is available online: water.usgs.gov/nawqa/pubs/nitrogen_loads/
- Possible applications of SPARROW to the APENP region include locating which areas contribute the largest amount of total nitrogen annually to the stream network and determining which sources contribute the largest amounts of total nitrogen annually to Albemarle Sound. Using a graph of nitrogen sources to the Albemarle Sound, Anne

noted that a lot of fertilizer is being applied into the catchments, but a much smaller amount actually makes it to the catchment basins.

- Anne showed an example using an online decision support system that will go live in March. The example used a 50% reduction in agricultural sources to result in a 20-25% reduction in total nitrogen. Anne clarified that if you reduce fertilizer and animal waste inputs by 50%, you see various reductions. In three cases, you get a 20-25% reduction in loading.
- Don Stanley pointed out that a 10% reduction in agricultural sources would result in little reduction in total nitrogen. Don concluded that as long as agriculture dominates the landscape in these watersheds, we aren't going to experience much of a reduction. Anne noted that the model does allow you to generate confidence intervals.
- Don noted that there has been a lot of emphasis on best management practices (BMPs) in agriculture. Anne noted that you can't just focus on one source. Robin Dennis stated that one-third to one-half of atmospheric deposition is coming from agricultural sources, so the model results for nitrogen should be higher. He noted that it is built in, due to the volatilizations, and Anne agreed.
- It was noted that some physical BMPs could alter some of the delivery factors. Anne agreed this factor was not accounted for in the model.
- Dean noted that another strategy would be to target areas for BMPs, which were closer to the Sounds. Don agreed and indicated that targeting "close" nitrogen would likely be more effective. Mike Piehler asked Anne if she had data closer to the coast, noting that most gages are further inland. He noted that most decisions close to the coast are based on sparse data.
- Kirk Havens asked if the model addresses all variables associated with groundwater lag time and other inputs. Anne noted that SPARROW models a static condition and does not presently accommodate lag times. Future scenarios simulate conditions after everything comes back into equilibrium. The takeaway message is that SPARROW does not ignore groundwater, but it also does not explicitly address it.
- Anne presented a table of example, real-world applications of the model. SPARROW has been used to validate another watershed model, evaluate change in nutrient delivery to target from proposed changes in input, calculate in-stream loads to match desired delivery rate to target, evaluate nutrient trading scenarios, and as a framework for collecting additional data.
- Addressing the pie chart of factors contributing nitrogen, Don asked what might happen if humans were removed from the landscape. As other sources drop away in the absence of humans, is there a missing source of nitrogen? Anne indicated that part of the nitrogen would be coming from natural background sources, such as deer. Inputs from such sources are being absorbed into one of the model's five categories.
- Fertilizer data is not based on application data but rather county-level fertilizer sales data. This data has been pared down to the catchment level. Don commented that some models attribute most of the nitrogen input to estuaries as human-related, and this could overestimate the potential for reduction. Anne indicated that in this case, the atmospheric inputs might be the closest to a natural input.
- Robin noted that some studies suggest that natural inputs may make up as much as 10% of total nitrogen in the system. Based on census data, going back to the 1860's, 80-90% of nitrogen inputs are associated with human inputs.
- Don commented that ecosystems must be fairly resilient to handle a five-fold increase, and yet we can still go out and catch a fish. Robin stated the fisheries could be very stressed as well. Kirk noted that groundwater lag time could make it 20 years before we see the impact. Don stated the big increases came with modern agriculture, 40 years ago,

and we really haven't had any increases, since little land is being converted to agriculture. Robin noted that we have had a huge increase in CAFOs. Don noted his second point was that we as a society have decided that we have to have continual economic growth, and this requires more humans and more inputs.

- Jon, Toddi and others did not especially agree. Toddi felt that the point was not to criticize the fine details of the model, but to understand what is going on. Jon noted that we could use more efficient application processes for fertilizer, for example, to reduce that component.
- Rhonda asked if the model was lumping some factors, which may not just be due to atmospheric deposition. In this case, small BMPs may not be seen as beneficial. Rhonda asked if SPARROW addressed buffer size and wetlands acreage and suggested that it would be good to put these factors into the model.
- Anne noted they are trying to do this at a regional scale, and it is difficult to find data in uniform coverage. The model can be calibrated for a smaller basin. Some states are using it this way. Because the number of data points can be limited, the model may not be as robust.
- Rhonda noted that it would be good to have models based on known data. As an example, Rhonda noted how they have looked at fertilizer use in urban areas in southwest Florida. Many of the counties have banned fertilizer sales during the rainy season, finding it was more of a timing issue than a concentration issue. In this case, it was more of an urban issue.
- Anne added that SPARROW was designed to look at regional issues. It provides a starting point, and the modeler can investigate refining a watershed-based model if they are interested in a more localized application. The applications shown during this presentation are more broad.
- Comments were made suggesting to re-focus the discussion on how the model can influence policy rather than dissect it. Anne continued with a review of applications in the Neuse River Estuary, Pensacola Bay (Florida), and in the Upper Neuse River basin.
- At Pensacola Bay, SPARROW was used to estimate the fraction of nitrogen delivered to the Bay from multiple load points in the watershed.
- In the example from the Upper Neuse, the model was used to evaluate nutrient trading scenarios within Falls Lake watershed. This work is being performed by J.R. Rigby, a post-doc at UNC-Chapel Hill. Analyzing nutrient-trading scenarios among NPDES dischargers, nitrogen loading to Falls Lake is minimized. The model explains how dischargers could trade abatement credits depending on the assimilation between the discharge points.

Assessing and Managing the Impact of Urbanization on Stream Ecosystems by Application of a Bayesian Modal: Roxolana Kashuba **note: presentations can be found in their entirety on the STAC website.*

- Roxolana Kashuba is an Environmental Modeler with the USGS. She presented research results and insights from use of a statistical model that links urbanization to the Biological Condition Gradient (BCG) of stream ecosystems using a Bayesian Network.

- To gain a better regional understanding of how urbanization affects stream systems in urban settings, the USGS commissioned this study as part of the NAWQA Program. Nine regions were selected across the country, and data collection took five years.
- Modeling challenges associated with urbanization include: multiple stressors acting simultaneously, incorporate knowledge of teams of subject matter experts and data into

model construction; align the effects of urbanization to a management endpoint; and rank management options.

- Roxolana explained the approach to developing a Bayesian network model. The process is to build the model, update the model, and evaluate the model. The model incorporates expert knowledge, including input from biologists, water management professionals, habitat scientists, and urban planners/managers. The focus is on science and confirming or denying expected relationships. Experts are able to give an integrated estimate of system uncertainties base on all information synthesized from career experience.
- Benefits of this approach are: decomposable, efficient, flexible, updatable, transparent, and ultimately it can be linked to the BCG. The Bayesian method has a quantifiable management endpoint. Roxolana noted this method can model any type of variable, and once new expert input becomes available, the model can be adapted.
- The BCG is defined by six tiers of biological condition – natural condition to extreme change in structure. The goal of BCG is to actually quantify the model relative to an urban stressor.
- The goal of a Bayesian network is to predict a given state, from knowing one or more variables. The joint distribution of variables can be predicted based on the known distribution of variables. Bayes Theorem can be used to update the model each time new measured data are available.
- The model can also be used to do sensitivity analysis. Roxolana gave an example using decreasing flashiness as the input of interest. Further analysis shows that managing flashiness has a greater impact than managing for substrate or conductivity.
- Roxolana concluded: you can use this model to rank likelihood of attaining desired management endpoint given different management actions. The model supports EUSE urbanization regression work but operates in a more integrated, comprehensive framework. The Bayesian network shows BCG can be modeled from a small set of inert metrics, in terms of probability of attaining each BCG tier.
- Roxolana reviewed the benefits of the new framework: increases conceptualization of environmental and ecological processes; able to analyze entire system together; interactive end product; flexible modeling construct; and enormous potential for use in environmental management decision making.
- Wilson noted that Dr. Ashton Drew is developing such models for US Fish & Wildlife Service. The various species being modeled with this approach include: king rail, Swainson's warbler, American shad, and blueback herring.
- Tim Spruill asked Roxolana if there were any examples where the models have been verified by actual field data. She noted that it is difficult and requires long-term monitoring. The largest investment in this modeling process is the expert prior work. A drawback to this approach is the willingness of the agencies to commit to long-term investment.
- Enrique asked how comfortable Roxolana was with the BCG. Roxolana indicated that as long as each variable was measured at the same scale, you could have confidence in the gradient. Enrique asked about moving to a different scale. Roxolana indicated that you would have to collect data to match the scale. If you have watershed-scale urbanization, then you must sample accordingly. Enrique asked about using the model at different temporal scales. Roxolana noted that you cannot model feedback loops, so each run of the model is a snapshot in time.
- Joe noted that some of the variables in the system have to do with thresholds, and he asked if that was assumed to be incorporated in the experts' opinions. Roxolana indicated the cutoffs are defined by input from the experts. As the experts decide how

the variables affect BCG, they articulate how the bins should be configured to accommodate the experts' knowledge.

- Tim asked about incorporating information from different areas to develop solutions and also to verify the impact of management decisions. This modeling approach appears to be ideally suited for solving complex problems. He noted it would take some significant funding but also was surprised that it had not been tried 20 years ago. Roxolana noted that it has been used in several different fields. In situations where there are multiple potential causes of some variables, you can generate diagnostic probabilities and investigate the potential for different causes. This application is used in medicine. Tim noted that was the benefit of putting things in probabilistic terms. Falls Lake is a complex case in point. It is a good application for developing a model for a management approach. Roxolana noted that sometimes it is a good management tool.

Working lunch: CCMP Development Update: Dean Carpenter and Kirk Havens

- Dean Carpenter, Program Scientist, and Kirk Havens, STAC Executive Board Member, briefed members on progress in developing APNEP's 2011 Comprehensive Conservation Management Plan (CCMP).
- The original CCMP was published in 1994. Dean provided an overview of the CCMP process for 2011. APNEP staff anticipate having a draft document that is ready for review this spring. Most other National Estuary Programs conduct periodic revisions of their CCMP, and it is the intent for APNEP's plan to be an iterative process in the future.
- Ecosystem-based management (EBM) is a primary tenant of the new plan. Dean reviewed the objectives of the process. In 2009 the STAC summer meeting focused on EBM. Following that meeting a proposal to follow an EBM approach was submitted to and approved by the APNEP Policy Board. The EBM transition team has been meeting on a regular basis since January 2010 to integrate EBM approach into the new CCMP.
- Dean reviewed the proposed changes to the CCMP structure. The original plan was based on water quality, vital habitats, fisheries, stewardship and implementation. The new plan is structured around five questions. Dean explained how the plan would be built around the five questions, and he defined the following in the plan: goals, outcomes, actions, indicators and targets. Goals will address three areas of concern: human communities, native communities, and water quality/quantity.
- Dean noted that APNEP, with contributions from STAC members, is in the process of doing a new ecosystem assessment for the Albemarle-Pamlico system. We are also conducting a basic threat assessment.
- Dean requested feedback on the materials that were provided to STAC members. Staff will use this input to evaluate the draft actions. The Policy Board, Citizens' Advisory Committee and Management Advisory Committee are also being solicited for input.
- Dean selected Objective B1 and its associated Actions to use as an example. B1 is part of the "Protection" Strategy (B), and Objective B1 states, "protect water quality by eliminating targeted sources of water pollution." Do the actions listed cover what we can expect to achieve during the next five years? Consider what may be missing and prioritize which Actions are more important. Is the identified issue in fact manageable? Which individuals are working in the areas specified?
- Kirk stated that we also want to know what the impediments and/or advantages are to achieving actions. He would like to hear how manageable the threats are, from a low-medium-high perspective and who if anyone is working on these.

- Dean noted that staff are not attempting to quantify things more than that at this point. Each action will have associated steps that will be introduced in the APNEP annual work plan.
- Tim noted the actions look good but asked how the implementation will take place. Dean replied that the plan is the result of all the individual partners, since NEPs are stakeholder-driven partnerships. As an example, he noted that the directors of the state water quality programs in Virginia and North Carolina will provide input into this plan.
- Rhonda Evans gave an example of the Tampa Bay Estuary Program's (TBEP) effort to restore sea grasses. TBEP has been very successful in bringing sea grasses back to historic levels through TMDL development and nutrient management. Tim noted Tampa Bay is very different from the Albemarle-Pamlico region, with lots of residents living on its shores and changes being very visible to them.
- Rhonda mentioned potential funding through different grants to assist communities in the Albemarle-Pamlico coastal plain with restoration projects. The key is to tie funding back to goals and actions in the CCMP. Look at what is most important to target and focus actions. Available funds include those directed toward low-income communities.
- Jon asked if it would be advantageous to take the actions and reduce them down to the three that are the most important. He noted that two or three of them might be impacting 90 percent of water quality. Dean noted the EBM team has already done some honing down of the actions. The actions presented at this meeting came out of that process.
- The next step of this process is to begin a dialog with agencies, or managers, who work in these areas. Staff plan to make actions "SMART" (Specific, Measurable, Attainable, Realistic, Time-Bound). For example, instead of CCMP Action B.1.9 saying "increase the use", we will specify an amount to achieve along with a defined metric.
- Don commented that he would like to see watershed plans address the root cause of impacts. He noted the increase of human population in North Carolina. He used action B1.7 as an example, which states, "reduce percent of impervious surface in new development through use of Low Impact Development (LID) practices." This is a laudable goal, but the cumulative impacts associated with development over the coming decades haven't gained anything.
- Don's point was that achieving these goals will be easier if we limit or control growth. Scientists could offer a *disclaimer* that results cannot be guaranteed if growth continues. He would like to see language along the lines of "limit, reduce, cap, etc." growth. A stronger statement would be that we as scientific experts can't guarantee that these goals can be attained as long as growth continues. He has never seen that kind of statement in this kind of document.
- Kirk stated it would be better to highlight what aspects of growth are keeping us from reaching the goal. Don stated that would be fine. Our model of economic growth is not likely to change in the near future, and education will be a key effort to help reach these goals. The long-term incompatibilities between economic growth and environmental impacts need to be addressed.
- Kirk noted that education is included in the original list of actions. Dean noted that engagement is one of the strategies. Also, part of the EBM process is the sociological dimension.
- Climate change and land use are the two main drivers affecting what we define as a healthy system. Dean said these are both symptoms of growth. APNEP is not a regulatory program, and we would have to work through partners to achieve regulatory-type actions.

- Wilson noted that he agreed with what Don and Kirk were saying. He noted that Toddi had suggested we invite a researcher to speak to the STAC who had done a study of the last CCMP. He felt that would be very useful and informative.
- Don noted that we should consider putting in a statement that more government regulation is needed to achieve goals unless we have fewer people on the landscape.
- Jon wondered if these actions have already encompassed some of the necessary actions. He noted that a bold objective would be to have no more impervious surfaces. He noted that it was unlikely to happen. Kirk asked if anyone is advocating that now.
- Tim agreed that the one variable which correlates with environmental degradation is population growth. Perception ties back to what is a healthy society. Action item – look at the document that Dean has delivered, and provide feedback.

Assessing Long-Term Intertidal Oyster Reef Restoration: Joel Fodrie
**note: presentations can be found in their entirety on the STAC website.*

- Joel Fodrie, STAC member, briefed members on the results of an APNEP-funded research project in the Rachel Carson National Estuarine Research Reserve. This research assessed the importance of landscape position and deployment depth in the evolution of 15-year-old restored *Crassostrea virginica* reefs.
- APNEP has funded much of this research project, along with NC Sea Grant. The project area is largely in the Rachel Carson NEERRS.
- Joel provided a historical perspective on NC intertidal oyster reefs, intertidal reef restoration in the 1990's, the evolution of those reefs, and building new ones. Oyster reefs in this area were historically vast.
- Joel mentioned some important historical references, including Winslow's report (1886), Graves (1904), and Coker (1907). Research on the basis for reef restoration dates back more than 100 years. Intertidal reefs were viewed as not as valuable as the subtidal reefs. Joel showed us the map of the intertidal reefs around Ocracoke Inlet. There is only one reef left in that area. The intertidal oysters have a very narrow morphology, in comparison to the subtidal oysters which are rounder in outline. The intertidal reefs were lost over time. The NC Division of Marine Fisheries (DMF) restoration efforts are focused on the subtidal reefs. There has been no intertidal restoration work in central North Carolina until the 1990's.
- Graves' 1904 paper notes that natural reefs grow perpendicular to the shoreline. Now, we build living shorelines parallel to the shore. We should think about how we restore versus how reefs have historically been observed.
- Joel talked about restoring intertidal reefs using derelict fishing gear. This is not a new idea and dates back to Japanese aquaculture in the 1800's. APNEP is funding a study to take derelict crab pots and use them as substrate for intertidal oyster reefs. The pots get the oysters up into the water column where they are less subject to predation. Joel noted that none of the early publications on the use of structures to build oyster reefs are under copyright. He has them all digitally and will provide them to anyone who wants a copy.
- Oyster landings have declined through most of the Twentieth Century. Some expansion of habitat has happened in the last 15 years. Don asked about landings in Louisiana and how they compare to North Carolina, if normalized. Joel noted that part of the reason for the production in Louisiana is due to the productivity of the Mississippi. He noted that both oysters and spotted seatrout were much larger in that area.
- Joel reviewed intertidal reef restoration in mid-1990's. Oyster reefs were constructed in 1997 by John Grabowski. They were built in varying locations: in mudflat, saltmarsh, and saltmarsh-seagrass habitats. The mudflat reefs prospered while salt marsh and

seagrass lagged behind. It was observed that higher flow leads to better feeding rates on the mud flat. Joel noted that the salt marsh reefs have more predators and less flow than the mudflat reefs.

- Joel noted they are interested in how the fish use these reefs. Mullet eat detritus as they swim by, and sharpnose and blacktip sharks are sometimes present in very shallow water. Resident species include gag grouper, gray snapper, sheepshead and flounder.
- Gill nets are used for sampling. In the 1990's John Grabowski did his sampling at night. The catch rate of fish was higher on the control site than on the reef sites. From the recent sampling, the salt marsh reefs do more poorly than the other habitats. This is due to the reefs building habitat to the point where they are no longer accessible. Some NCDMF reefs built in salt marsh no longer exist.
- Joel indicated there was a significant trend for anglers to catch more fish on the reef sites than on the control sites. He just received this data on Monday, prior to the STAC meeting. The gill net data show equal numbers, but the hook and line data suggest the fish are feeding on the reefs. Joel hopes to confirm this with a gut-content analysis.
- Joel and his collaborators also studied where the reefs are physically located. They used laser scanning and surveyed the reefs to determine elevations. Joel showed photos and digital interpretations of two reefs. Using these images they can assess how the reefs have grown. In 1997 the entire reef volume was 1.67 cubic meters. In 2010 it was 9.34 cubic meters. Joel noted that growth appears to be exponential through time, but they only have one data point thus far. Joel showed a video of the laser imagery. Ray feeding pits show very clearly on the imagery.
- Don asked if these reefs were protected from harvesting. They were initially protected from harvest, but being at the Rachel Carson Preserve the reef was opened up to recreational fishing. Would Joel's team be able to keep up with this harvest in terms of the impact on their research? Joel answered no, but they do see people out taking shellfish.
- Cores were taken to look at reef development. They didn't find any net accumulation of shell in one habitat. They are curious now to do a carbon budget. They want to determine whether they have created a carbon sink or source. At the mudflat reef, it appears the reef may be a carbon sink.
- There is a strong relationship between the health of the oyster community and the depth of the reef. Joel has observed no oyster growth below a depth of 0.6 m below mean tide. As an example, Joel showed a band of oysters on a seawall in Beaufort, which decline with depth. To contrast, on the Core Creek Bridge there are oysters all the way down. What is different in Core Creek versus Middle Marsh? Joel talked about potential culprits for reef demise below a threshold depth. One element is the boring sponge. It will bioerode marl substrate as well as oyster shell. Oyster drills are another predator. They do not tolerate freshwater, but in salty areas they are abundant. Joel is working with fishermen and NCDMF to assess the abundance of boring sponge. They have data from Wells (1950) that show less density than the more recent data. Joel indicated that crabs have a preference for oysters which have a higher infestation of sponge. Temperature and or the marl could potentially be playing a big role.
- There are multiple stressors on the reefs. Sedimentation from silviculture is one. The places where fishermen work have lower infestation rates, which may be a reflection of fishing. Joel has a student looking at algae in Middle Marsh. Algae grow more profusely at the lower levels. Wilson noted that he had seen black-necked swans in Chile feeding on Ulva, and he wondered if the historic decline of waterfowl in North Carolina could be related to algal densities. Joel noted that he hadn't thought about that connection. He

noted that gulls select the higher elevation reefs on which to drop clams, causing damage to the reef.

- There are complex synergisms between oyster predators, crabs, and drills and the oysters themselves.
- Joel addressed the ongoing restoration. His team plans to build small reefs like those of Grabowski, as well as bigger reefs. The shell will be deployed in April at four different depths. They want to know how ecosystem services scale with location in the intertidal zone. They will look at oyster settlement and growth; denitrification; biofoulers, bioerosion and parasitism; and finish use and production. In addition, the implications for climate change will be studied.
- Joel ended with restoration guidelines taken from the rocky intertidal, developed by researchers on the west coast. The lower limit is set by biotic stressors (predators). Barnacles would love to live lower in the water column, but they can't escape the predators that way. The same is true here when the reefs are in higher salinity waters. There is tremendous competition for space in the upper elevations. They need to test these hypotheses in South Carolina and Georgia.
- Joel concluded that intertidal reefs formerly were a huge ecosystem component, and restoring them presents unique challenges. Restored intertidal reef success depends on the effects of the landscape, and potential fine-scale threshold effects of depth. They are using the rocky intertidal paradigm (vertical zonation) as appropriate for intertidal reefs. The study is still revisiting concepts known to researchers in the past.
- Robin asked about the effect from sea level rise. Joel noted the mudflat reefs are accreting. He noted that he hasn't been able to find any data about how fast an oyster reef grows. It would appear that based on the mudflat reef data (growing ~ 3.5 cm / year), the reefs can keep up.
- Tom Crawford asked about the recreational fishermen that were paid to fish at sites. Joel talked to people that he could "trust". He wanted it to be fun, while maintaining a standardized methodology. Control sites were established. The angler must stay within one cast of the reef, and sites were selected to represent every type of reef. In principle they fished the spectrum of reefs.

Assessing the Regional Impact of Future Climate Change on Coastal Vegetation by Application of a Watershed Simulation Model: Enrique Reyes
**note: presentations can be found in their entirety on the STAC website*

- Enrique Reyes, STAC member, briefed members on the results of a NOAA-funded research project that featured a section of landscape in the lower Neuse Basin. A watershed simulation model incorporated future scenarios of increased storm frequency and intensity, variable precipitation and drought, and increased sea-level rise (SLR) to examine wetland survival potential.
- Enrique attempted to show a simulation for the change in salinity, associated with SLR in coastal North Carolina. He noted that at the end of the day, salinity would ultimately kill the oysters. He noted that this presentation would talk about the regional impact of climate change on coastal vegetation. They want to analyze what coastal Carolina will look like as it is assaulted by SLR. The research looks at the regional picture to address conservation issues. Strategies include stewardship, stakeholder participation, and scientific-based decision-making. The goal is to create a landscape model focused at the mid-and long-range temporal spatial scales.
- In the study area of the Neuse River, all habitats were classified using an aggregation scheme. The resolution was a quarter of a square kilometer, and each cell has a set of

algorithms that model the biological and physical ecosystems. The models are derived from published literature, and a feedback loop can be built into the system. To assess whether the model reflects reality, they compared historic satellite images to simulations. The study looked at changes from 1991 to 2001. You can tell where changes have occurred by comparing maps or doing a cell by cell comparison. Over the decade, the historic rate of change for the Neuse was around 15%..

- Enrique showed the cell numbers from Year 1997, in comparison to the Year 2047 projections. The habitat with the greatest losses is forest as SLR increases and the salinity rises. The model also shows the gain in open water. Enrique noted that if you triple the rate of SLR you approach the rate of the last glacial maximum in the Holocene. They also modeled a 50 mm annual rate, which would happen if the Greenland Ice Sheet melts. In that scenario, the Outer Banks are gone and the sound changes to oceanic habitat.
- The last analysis Enrique showed was a risk assessment of the Outer Banks. The consequences of a breach of the Outer Banks are tremendous.
- Enrique shared his conclusions: historical maps don't show a clear effect by relative SLR; the "Big Squeeze" is already happening; and migration opportunities for coastal vegetative communities are being severely reduced. Confounding effects include development and forestry, and regional simulations are a useful approach to evaluate the effects of SLR.
- Jon asked if the imagery used for this study was Landsat. Enrique confirmed yes. He added that they knew they could go back further using aerial photography as well as Landsat.
- Tom asked whether the study used historical data to get results and then compared to actual satellite imagery. Enrique stated yes, that is where the 15% originated. Was the 2001 data used to simulate to 2047? No, they started with 1991. Tom clarified that they are using the validated data in a different way. Enrique clarified that there is 15% which isn't in the model. He conducted a validation exercise with historical data. Using the statistic "fit" to compare the two images. Tom indicated that his point was that they were using the statistic in two different ways. Dorsey asked which data set he was using, CCAP or NLCD? It was CCAP. Dorsey said this was the better set to use. Enrique noted that some habitats were consolidated in his work.
- Dean noted that Enrique had concluded the regional models were useful, even with single drivers. He asked if multiple drivers could be used. Enrique stated he felt that it would work, although it was tricky to simulate development trends. They are influenced by policies, but you can model restricting development to the criteria used in the 1990's.

Assessing North Carolina's Forest Resources: David Jones
**note: presentations can be found in their entirety on the STAC website*

- David Jones, Forestry Non-Point-Source Senior Specialist with North Carolina's Division of Forest Resources (DFR), shared approaches used in crafting a statewide 2010 Forest Resources assessment, including lessons learned that could benefit assessors who are contributing to APNEP's 2011 ecosystem assessment.
- The statewide forest assessment was long overdue. During the update, the assessment underwent several name changes, and David suggested that others going through a planning process stick with just one name. The assessment was required as an amendment to the Cooperative Forestry Assistance Act, as enacted in the 2008 Farm Bill. There was a redesign of the program at the federal level.

- The assessment was a collaboration between the states (National Association of State Foresters), the US Department of Agriculture (USDA), and the US Forest Service (USFS). There was a three-phased approach, which David reviewed: a state-wide assessment of forest resources; a state-wide forest resource strategy; and an annual report on the use of funds.
- David noted that the majority of North Carolina forest lands are now private. These parcels are being chopped up into ever smaller pieces, often the result of multiple heirs inheriting a property. The state wanted to develop strategies to address this issue.
- David presented a schematic showing the approach taken by North Carolina. He noted the process worked only as well as the components worked together and gave an example. David pointed out that APNEP was dealing with similar issues, with their Resource Monitoring and Assessment Teams.
- David talked about protecting forests from harm. This topic dealt mostly with insects, diseases and fires. David noted they looked at many topics. He addressed the product dealing with water quality and quantity, reviewing one chapter. Federal agencies provided guidance to help the assessment. The point of emphasis here was to identify forests which are important for protecting public water supplies.
- Trends in forestland cover were mapped using a 12-digit HUC (hydrologic unit). They used a 70% cover as a threshold level. The map shows great changes. Toddi asked if there were any places which grew from below 70% coverage to over 70%. David stated that there was no afforestation on a subwatershed level. Deforestation was the theme.
- The other task they had was to address water supply and demand. They used data from the Rural Economic Development Center, Water 2030 report. David showed us maps of the relative value for water quality and quantity and explained the data layers that went into their development. They produced pixel-based and watershed-based maps. He noted the map is under revision.
- David reviewed the key findings: North Carolina surface water supply watersheds are 60% forested. Groundwater wellhead protection areas are 36% forested. Approximately two-thirds of the subwatersheds in the state have less than 70% forest or natural land cover. When a watershed's land cover falls below this threshold percentage, water quality conditions generally worsen.
- The conclusion is that based upon the rapid expansion of urbanizing areas in North Carolina, an opportunity exists to reevaluate and transform the role of forest management. David noted they developed a broad goal statement to manage, conserve, restore, and enhance forestlands important to current and future supplies of clean water for economic, social, and ecological uses. There are four objectives: increase implementation of forestry BMPs and compliance with water-quality regulations; retain or increase the acreage of forestland within priority watersheds; conduct education and outreach on the relationship between forests and water resources; and offer landowners technical assistance that incorporates water management measures on their properties.
- David shared some lessons learned: put someone in charge (a single person should have ownership of the overall project); stakeholder input is critical, but the agency charged with the task must be willing to synthesize viewpoints and move the project forward; pick a project name and stick with it (changing names is confusing); and create product standards and templates for documents and figures early on. GIS staff should be involved from the beginning of the process. As an example, David noted that they discovered multiple versions of county boundaries, which was difficult to sort out. You need to know what analyses are feasible given the available data. You can't use particular metrics if you don't have the data for them. David noted that they needed to have a GIS committee, as well as having GIS staff on the individual work groups. The

last lesson learned was do not speed through the assessment to get to the strategies. David stated you can't properly frame the questions unless the assessment is complete.

- The assessment is available for download: www.ncforestassessment.com/
- Tim asked if it is a priority for the NCDFR to encourage development of forest cover to the 70% level. David stated that it has not been historically. The Implementation Committee is trying to determine how they are going to do this. They are working on a program to do a forest watershed assistance plan. Common points of emphasis have been forest health, tree health, and silvicultural practices. They can look at opportunities for wetland and stream banking opportunities and connect landowners with conservation opportunities.
- Don asked if converting agriculture to forestry would make economic sense. Don noted that he was thinking of it as an offset for urban loss. David stated that a key is to demonstrate that ecosystem services have value in regulated markets, such as mitigation banking, until carbon credits come along.
- Dean asked David to revisit the objectives slide. Dean stated this is a good example of obtaining more refined actions. APNEP staff has been gathering plans from other agencies and partners, which will form part of the basis of our assessment. Objective 6.2 seems to be one we can attach a numeric goal to, and he indicated APNEP staff will be in consultation with NCDFR about this. Dean asked if we could make Objective 6.1 more specific. David said we could, but it would possibly be controversial. David noted that Dean brought out a lot of good points. Dean noted that there are some very explicit goals. David added that this assessment will be updated again in five years.

Action Items:

- STAC Co-Chair Wilson Laney will confirm Committee action items to be completed by the STAC spring meeting (April 27).
- The only action item from the meeting is for the STAC membership to comment on the draft CCMP objectives and actions. Dean would like them by a week from tomorrow (February 4). He will send out a reminder to the entire STAC.

** Reminder: The next STAC meetings are scheduled for April 27 2011 (spring) and July 26, 2011 (summer).*

The meeting adjourned at 3:00 PM.