FerryMon: NC DOT ferry-based automated monitoring of water quality and fisheries habitat condition in the Pamlico Sound System, NC

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SEMI-ANNUAL PERFORMANCE REPORT

Recipient: Hans W. Paerl

Grant Award #: 2013-H-006

Grant Title: FerryMon: NC DOT Ferry-based automated monitoring of water quality and fisheries habitat condition in the Pamlico Sound System, NC

Grant Award Period: July 2013 – June 2014

Performance Reporting Period: July 2013 – December 2013

Project Costs:

Specific cost information associated with this grant was removed before posting this document to the SEDAR Procedural Workshop: South Atlantic Shrimp Data Evaluation FTP site.

NOTE: Because there was a lapse in FerryMon funding due to the legislature cutting funding via DENR (November 2011-July 2013), we had to shut down the Pamlico Sound ferry for almost two years. With the initiation of funding through CRFL on July 1, 2013, it took several months to clean and de-foul the "plumbing", replace, service and calibrate equipment, re-establish data transmission and communications with the ferry. This led to a 4-month delay in getting the Pamlico ferry back on line (we were not able to charge technician time for collecting and

analyzing samples from the ferry during that time). The Ferry outage impacted our project timing and spend rate; however, now that we are fully operational I fully expect our defined scope of work and Year 1 budget to be expensed on/before 06/30/2014.

Description of Work:

The NC Coastal Habitat Protection Plan (CHPP; Deaton et al 2010) identifies the need to increase the coverage of continuous water quality monitoring so that water quality standards specific to fishery communities can be developed. In addition, the CRFL Strategic Plan highlights the objective to "identify, designate, and conserve fish habitat and SHAs". This project specifically addresses Strategy H.2.3, which aims to inventory and conduct research and monitoring to determine status of and trends in the six basic fish habitats, the water column in particular. The FerryMon program has two NC-DOT ferries outfitted with continuous, flow-thru water quality measurement systems and those routes are near to or go through areas nominated as SHAs in Region 2. Many of the parameters included in FerryMon's arsenal of water quality indicators address this strategy.

The project objective, therefore, is to use FerryMon to establish the status and trends in water column habitat conditions in the Pamlico Sound and Neuse River. The continuous nature of the FerryMon data collection capabilities also serves as an early warning system for significant changes in water quality conditions. Specific objectives include:

1. Use FerryMon's flow-thru detection system to monitor surface salinity, temperature, dissolved oxygen, pH, turbidity and chlorophyll *a* (Chl *a*, an indicator of algal biomass and potentially-harmful blooms) conditions in the APES, adding to the over ten year database.
2. Use time series analysis of historic data to establish trends in water quality parameters that specifically impact fishery species growth, reproduction, and survival (e.g., temperature, salinity, and pH). These trends will be then compared to trends in fishery-dependent and independent data for determining relationships that can be utilized to help refine stock assessment models.
3. Use the real-time data collection to provide rapid detection of significant changes in water column physical-chemical conditions pertinent to fish health. For example, FerryMon will be able to monitor wintertime temperatures and warn of potential cold stun or kill events.

Other, secondary objectives include updating and maintaining the FerryMon web site, www.ferrymon.org, which is used for communicating key findings to NCDENR (DMF, DWR), NGO's, educational institutions (K-12, universities) and the public, collecting nutrient and other samples using on-board automated water samplers, providing data for remote sensing calibrations, and measuring concentrations of CO_2 in surface waters with an in-line pCO_2 analyzer.

Project Status/Work Accomplished:

1. Monitor surface water quality conditions using FerryMon flow-thru system.

The components which make up the FerryMon flow-thru systems had been offline for almost two years due to a lapse in state funding, so the primary task to meet the first objective was to return the systems to working order. This task entailed fixing and replacing corroded fittings, calibrating and replacing bad sensors on YSI sondes, and loading and reconfiguring data collection software on computers. This work was completed quickly on the M/V Lupton, which

crosses the Neuse River, but took longer on the M/V Carteret, which crosses Pamlico Sound, due to scheduling limitations and unknown data logger problems. The system on the M/V Carteret is now working, although it appears there still may be restrictions in the water lines. Addressing this problem will require coordination with NC-DOT Ferry Division staff and is planned for the second half of the award period. Other than that, this objective has been met.

Cellular modems have been installed on the ferry computers that allow wireless remote communication to the data collection platform. Real-time conditions can be monitored by project staff from anywhere, although the current software still requires manual downloads of data files for quality control. A webcam has been mounted on the M/V Lupton, which now serves to inform the public (via the New Bern-Ch. 12 WCTI and Washington-Ch. 7 WITN TV stations and the FerryMon website) of water conditions on the Neuse crossing. Still planned is an upgrade to the data collection platform that would eliminate the hardware-based data logger and enable automated data transfer to the laboratory computer. The upgrade will utilize open source software and be extensible for future expansion or changes.

The data collected has been subjected to quality control checks and entered into the existing relational database. Almost 18,000 records of data collected from the M/V Lupton (Neuse River) during the reporting period have been added. Data from the M/V Carteret on the Pamlico Sound are still being checked for accuracy and suitability. On 3 December 2013, NC-DOT set up an emergency ferry route because of the closure of the Bonner Bridge over Oregon Inlet. The M/V Lupton was moved to that route until 15 December 2013 and the FerryMon system was able to operate during most of the period collecting water quality data from an area rarely sampled.

2. Time series analysis

Time series analyses were scheduled to begin in the second half of the award period so there is nothing yet to report for this objective.

3. Use real-time data to detect significant change.

During the reporting period there were no major events (i.e., no major tropical cyclones or nor'easters) noted that would have significant impact on fish health. Late in the month of January 2014, the system on the M/V Lupton recorded temperatures below 5 °C, conditions which have in the past led to cold stun events for spotted seatrout. The DMF contact for cold stun events, Chip Collier, was contacted and made aware of the conditions on the ferry route.

4. Other Accomplishments, Collaborations, and Outreach

The existing FerryMon web site was updated to include customizable plots of several water quality variables (Fig. 1). Visitors to the page can adjust the date range window and can change which variables are shown. In the example, the spatial variation in water quality can be seen. Higher salinity, temperature, and chlorophyll values were recorded on the northern, Minnesott Beach end of the route. The chlorophyll values (fluorescence) were at times quite high (above the 40 $\mu g\ L^{-1}$ TMDL acceptable water quality criterion), which corresponded to a dinoflagellate bloom identified a few days earlier.

A camera was installed on the bridge of the M/V Lupton looking out and connected to the internet via the on board computer. Images from the webcam are retrieved at one minute intervals and posted to the web site. An example of the webcam page is shown in Fig. 2. The images can be used to assess weather and sea state conditions on the river.

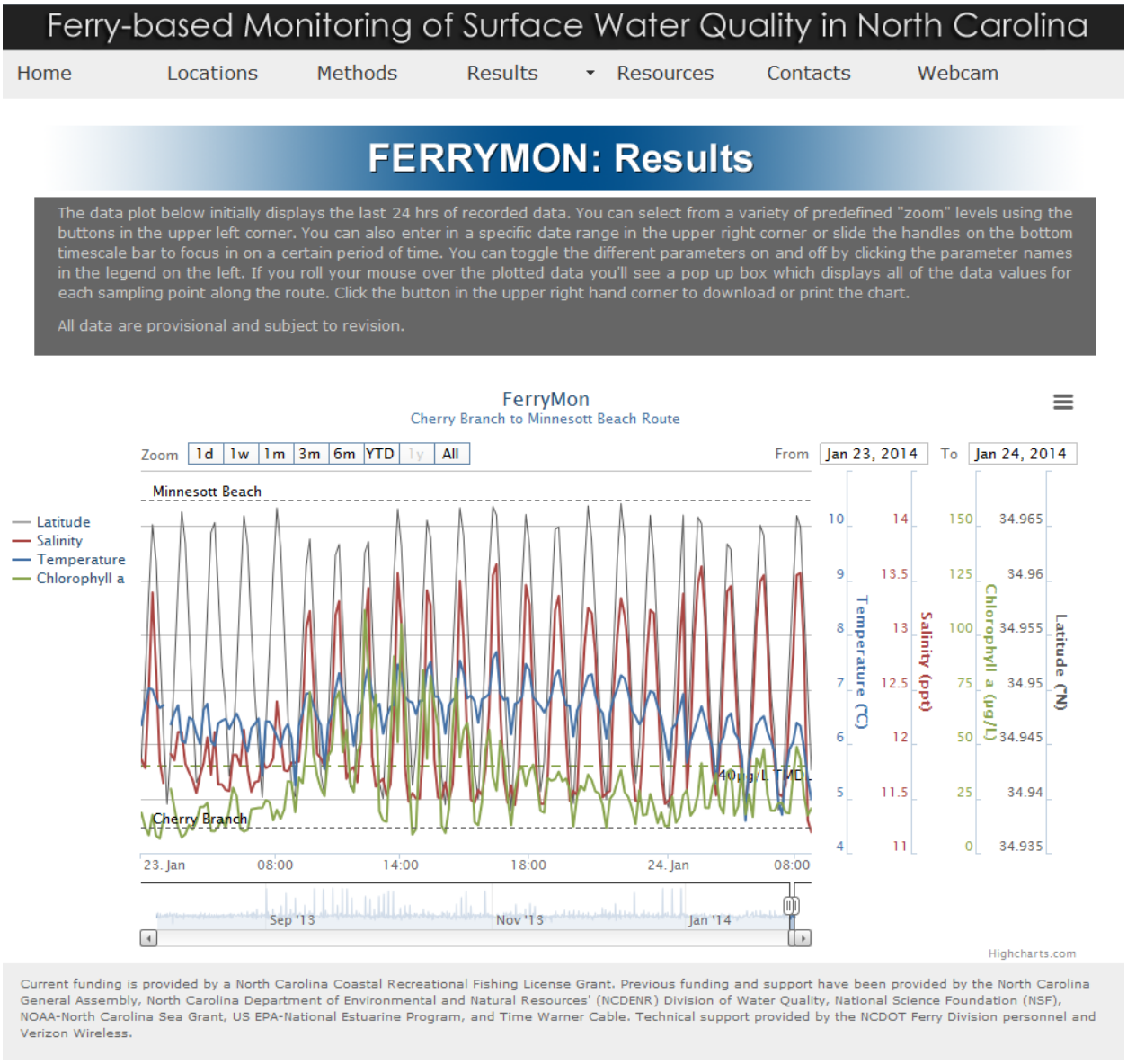

Figure 1. Example of FerryMon results from updated web site (www.ferrymon.org).

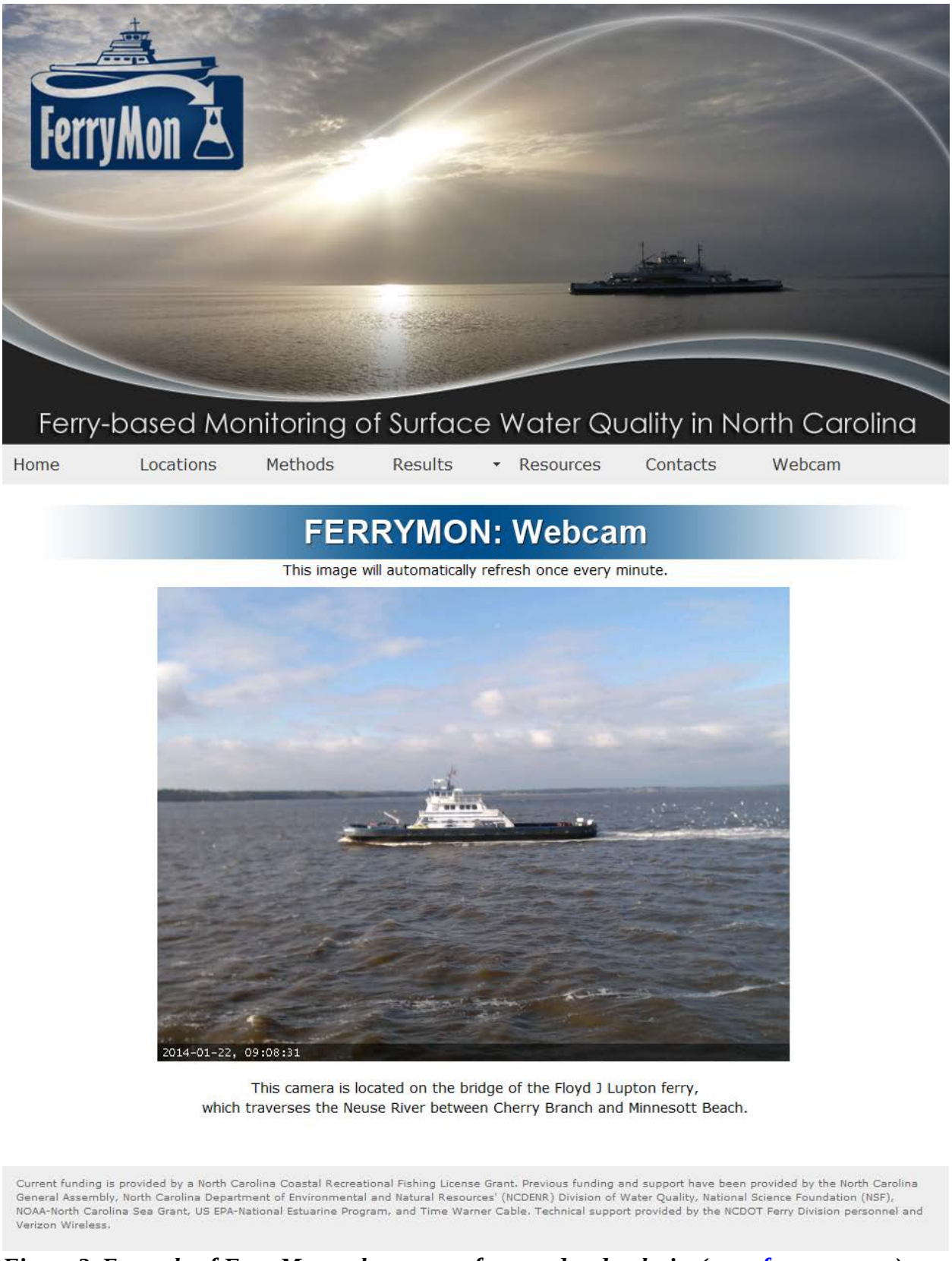

Figure 2. Example of FerryMon webcam page from updated web site (www.ferrymon.org).

Collaborations

The FerryMon project is engaged in, local, national and international collaborations in order to enhance and exchange the technology for unattended ferry-based water quality and habitat monitoring. Locally, FerryMon is providing data for NC DENR Division of Marine Fisheries (e.g., fish habitat condition and environmental stressors, such as cold stun and extreme variations in salinity) and the Div. of Water Resources (as a critical data sources for the chlorophyll a-based TMDL and Ambient Monitoring Program for the Neuse Estuary). In additions, we are collaborating with several ongoing CRFL projects (Drs. Joel Fodrie, Niels Lindquist, Michael Piehler, P.I.s) by providing crucial environmental data (salinity, pH, temperature, DO, turbidity). We are also collaborating with the Albemarle Pamlico National Estuary Partnership (APNEP) to provide environmental condition and educational information for researchers, educators, fishers, NGO's, tourists, environmental managers and decision makers.

Nationally, FerryMon is part of a multi-state ferry-based water quality monitoring program that is part of the Integrated Ocean Observing System (IOOS). A IOOS document outlining this collaboration and its products has been published in which FerryMon is prominently featured:

Codiga, D.L., W. Balch, P.M. Holthus, H.W. Paerl, J.H. Sharp, and R.E. Wilson. 2013. Ferry-based sampling for cost-effective generation of long-duration, repeat transect, multi-disciplinary observation products in coastal and estuarine systems. Integrated Ocean Observing System (IOOS) Summit white paper. http://www.iooc.us/summit/white-paper-submissions/community-white-paper-submissions/

FerryMon technology and informational output is now fully integrated with the European FerryBox program (http://noc.ac.uk/ocean-watch/shallow-coastal-seas/ferrybox), which employs 8 ferries to monitor water quality and habitat conditions in the Baltic and North Seas and adjacent fishing grounds (Dogger Bank, Gulf of Finland, Norwegian coastline), and major transportation routes (English Channel, Kattegat, Skagerrak). P.I. Paerl participated in the 5th FerryBox Workshop in Helsinki Finland in April, 2013 and presented a plenary lecture entitled "FerryMon: Ferry-based assessments of human and climatically-driven ecological change in the Neuse River-Pamlico Sound Estuarine system, North Carolina, USA".

Outreach Activities:

Several public presentations have recently been given that have featured FerryMon:

Irish, K, and A.R. Joyner. 2013. "Come Mister FerryMon, Monitor me Water". Albemarle-Pamlico National Estuarine Partnership-"Soundings". August, 2013. http://portal.ncdenr.org/web/apnep/2013-08-12

Paerl, H.W. 2013. "Progress with unattended water quality monitoring on the Neuse River Estuary. Integrating FerryMon and ModMon." Invited presentation to the Lower Neuse Basin Association/Neuse River Compliance Association. New Bern, NC September, 2013.

Paerl, H.W. 2013 "FerryMon and ModMon: Keeping a watchful eye on water and habitat quality in the Albemarle-Pamlico Sound System" Invited talk at the Albemarle-Pamlico Ecosystem Symposium: Embarking on a New Voyage, 20 November, 2013. New Bern, NC.

Paerl, H.W. 2013. "Unattended Ferry-Based Water Quality Monitoring to Evaluate Human and Climatically-Driven Ecological Change in the Pamlico Sound System, North Carolina, USA".

Poster presentation at the Albemarle-Pamlico Ecosystem Symposium: Embarking on a New Voyage, 20 November, 2013. New Bern, NC..

Hall, N. S. 2013. “FerryMon, Keeping an eye on the health of Pamlico Sound, Come what may?” Oral Presentation at NOAA’s North Carolina Sentinel Site Cooperative. Beaufort, NC, March 2013.

Interviews:

H. Paerl interviewed with WUNC-Chapel Hill about the FerryMon program, July, 2013

H. Paerl, interviewed with Channel 14 (Time-Warner) regarding FerryMon website and webcam services, January, 2014

Deviations:

There were no deviations from the major objectives. Maintenance is still needed on the refrigerated water samplers before they can be returned to service collecting samples for nutrients, sediments, and other water quality parameters relevant to habitat quality. A secondary goal is to establish remote control of the samplers’ programming and activation to allow event-based sampling. Corrosion and failure of water lines led to the disconnection of the pCO_2 analyzer and Algal Online Analyzer (AOA), which detects group specific phytoplankton biomass. These are still planned to be reconnected when possible.

References:

Deaton, A.S., W.S. Chappell, K. Hart, J. O’Neal, B. Boutin. 2010. North Carolina Coastal Habitat Protection Plan. North Carolina Department of Environment and Natural Resources. Division of Marine Fisheries, NC. 639 pp.