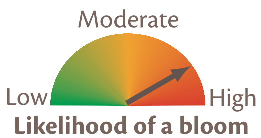
CHESAPEAKE BAY 2007
SUMMER ECOLOGICAL FORECAST

Produced by Chesapeake Bay Program's Tidal Monitoring and Analysis Workgroup.

This newsletter describes forecasts of Chesapeake Bay 2007 summer ecological conditions. Forecasts of three important Bay health indicators are provided–dissolved oxygen (DO), harmful algal blooms (HABs), and changes in aquatic grass distribution. This summer it is predicted that (1) the amount of anoxia (no dissolved oxygen) will be moderate in the Bay's mainstem and small in the Rappahannock River, (2) the extent and duration of HABs in the Potomac River will be average, and (3) aquatic grasses in the northern Bay, lower Potomac River, and Tangier Sound will undergo no or minimal recovery from losses sustained last year.

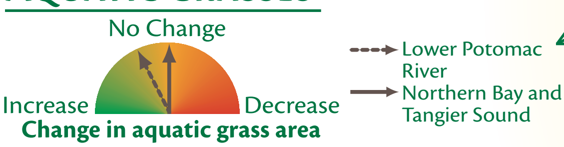
NORMAL WINTER AND EARLY SPRING RIVER FLOW SETS STAGE FOR MODERATE BAY CONDITIONS

Harmful algal blooms

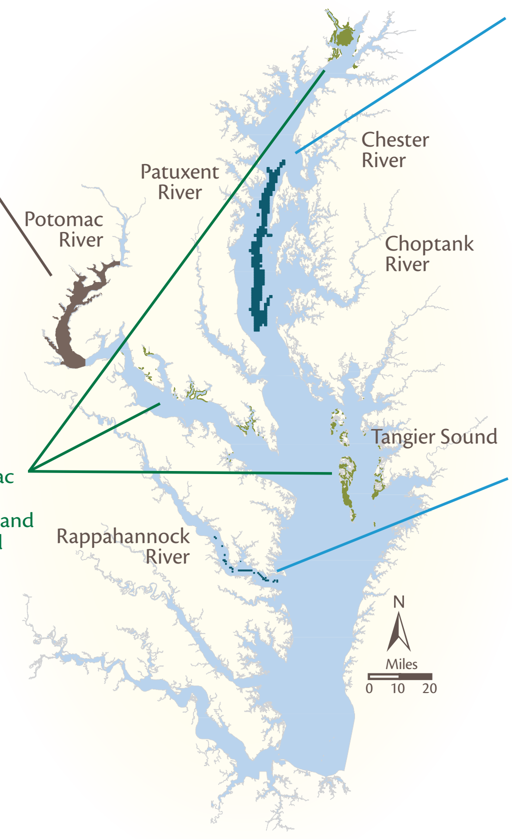


The likelihood of harmful algal blooms occurring in the Potomac River is moderate to high compared to previous years. Blooms are predicted to start in early summer, last for one to two months, and extend from 10 to 20 miles at their peak.

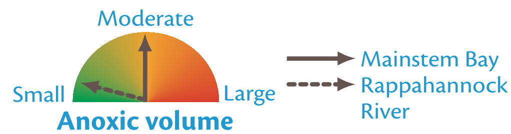
Aquatic grasses



No net change in aquatic grass area is predicted for the northern Bay and Tangier Sound regions this growing season. A slight increase in aquatic grass area is predicted for the lower Potomac River, following substantial losses in 2006.



Dissolved oxygen



Based on the nutrient loads delivered to northern Chesapeake Bay this spring, the mean anoxic (dissolved oxygen ≤ 0.2 mg l^{-1}) volume in the mainstem Bay will be 1.39 ± 0.52 km^3. Relative to previous summers, this volume of anoxia is considered moderate. The mean anoxic volume for the Rappahannock River is predicted to be 0.002 ± 0.003 km^3. While this is low compared to some years, it is not unusual for the river to have zero summer anoxia.

***Updates will be provided on the Chesapeake Bay Program (www.chesapeakebay.net/bayforecast.htm) and EcoCheck (www.eco-check.org/forecast/chesapeake/) websites.

Nutrient loading related to river flow

River discharge into Chesapeake Bay is a significant source of nutrients (nitrogen and phosphorus). As nutrients have a significant influence on the Bay's health, the forecasts are largely based on nutrient loads/river flow. Average Susquehanna River flow from January to April was within the normal range, although daily flow rates were variable (Figure 1). During January and for a short period in March, daily flow was often higher than normal, while February flow rates were often lower than normal. The forecasts do not account for unseasonable late spring or summer conditions, but represent the best available prediction based on past and present conditions.

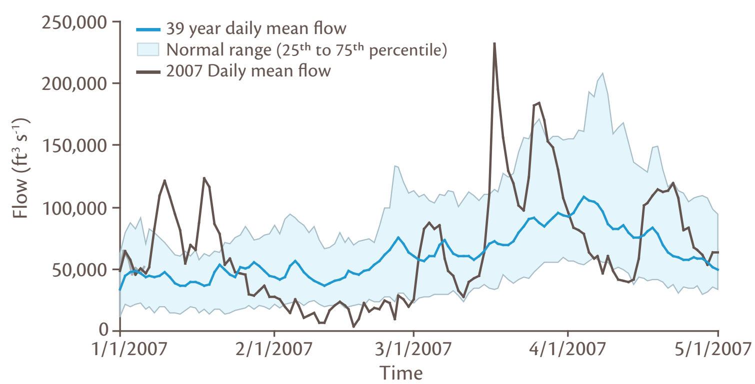


Figure 1: Susquehanna River daily mean flow rates from January through April for 2007 and the 39 year average. Data: USGS.

EXPANDING THE DISSOLVED OXYGEN FORECAST

The dissolved oxygen (DO) forecast is based on the relationship between spring nutrient inputs to the northern Chesapeake Bay and summer mainstem anoxia, which is expressed as mean June to September water volume with a dissolved oxygen concentration of ≤ 0.2 mg l^{-1}. We will also release a forecast of summer hypoxic volume (0.2–2.0 mg l^{-1}) when data become available in mid-June. To determine the mainstem anoxic volume, the forecast model uses flow related nutrients (total nitrogen and total phosphorus loads) from the Susquehanna River, which can account for 75% to 95% of the nutrient load, and point source loads (from upper western shore, upper eastern shore, and the Potomac River), which can account for the remaining 25% to 5%.

The Chesapeake Bay Program forecasts that the mean mainstem anoxic volume will be 1.39 ± 0.52 cubic kilometers (0.33 ± 0.12 cubic miles) for summer 2007 (Figures 2 and 4). Compared to the previous 22 summers, 2007 could have the 11th largest anoxic volume if this prediction holds true. Based on the forecast relationship only (not accounting for summer climatic influences) we are 95% certain that the mean volume of anoxic water will be between 0.87 and 1.91 km^3.

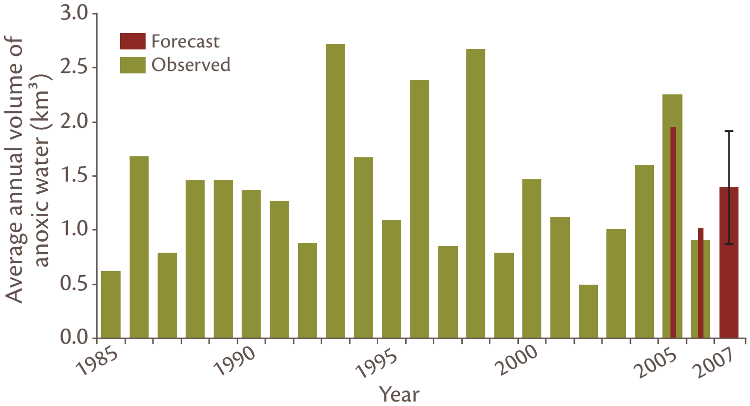


Figure 2: Dissolved oxygen forecast for the mainstem Bay in 2007 as compared to historical anoxic volumes and previous forecasts.

The Bay Program has recently developed summer anoxic volume forecasts for the Potomac and Rappahannock Rivers. Data for the Potomac River forecast will not be available until mid-June. The Rappahannock River forecast is based on the relationship between mean summer anoxic volume and the total load of nitrogen flowing over the Rappahannock fall line from January through March of the same year. The mean anoxic volume in the Rappahannock River this summer is predicted to be 0.002 ± 0.003 (Figure 3). Of the previous 22 summers, only 10 had measurable anoxia. Relative to these 10, the volume predicted for 2007 would be the smallest.

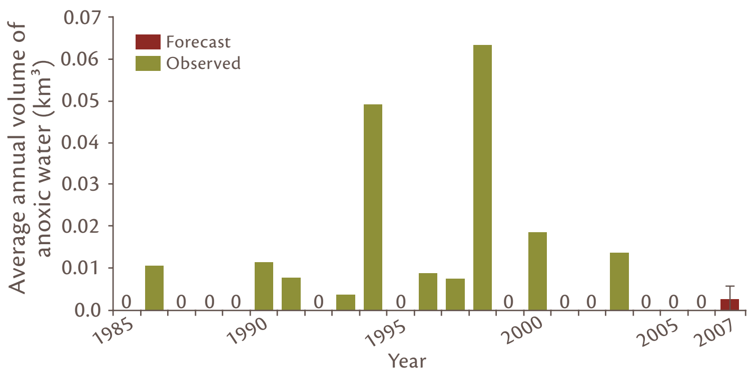


Figure 3: Dissolved oxygen forecast for the Rappahannock River in 2007 as compared to historical anoxic volumes.

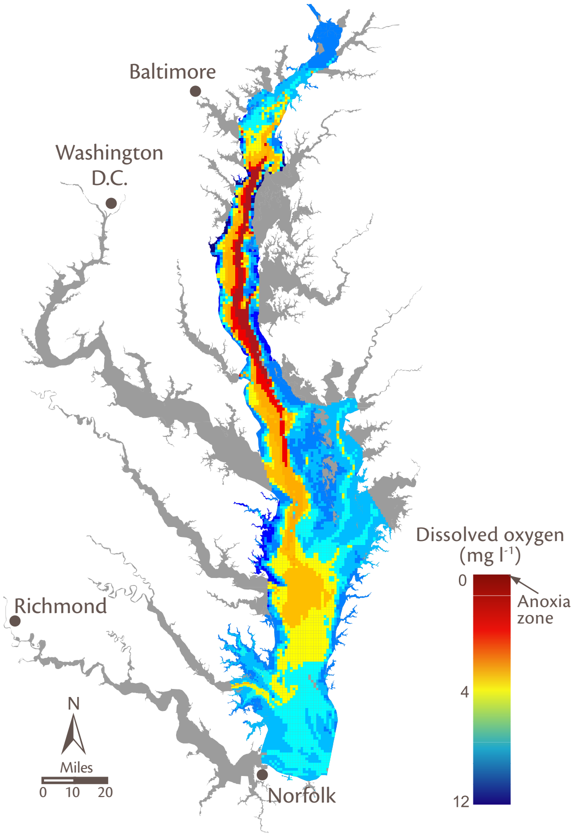


Figure 4: Dissolved oxygen in 2007 is predicted to be similar to 1990 anoxic volume.

There are certain factors, such as the wind the Bay experiences, that can occur this summer that can positively or negatively affect the distribution, magnitude, and duration of the anoxic volumes in the mainstem and the Rappahannock River. This includes the overall intensity and prevailing direction, as well as frequency of severe wind events associated with storms. More wind means more mixing of the Bay's waters and possibly less anoxia. The Bay Program continues to investigate factors that affect dissolved oxygen and may incorporate them in future predictive models.

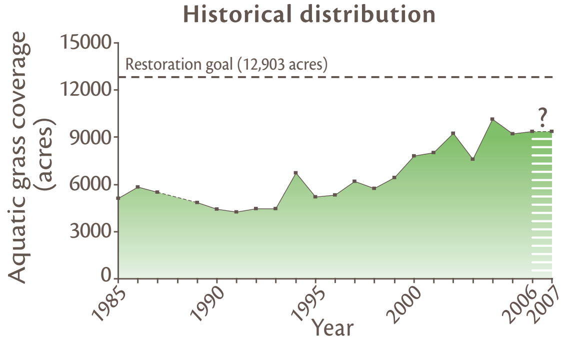
Alternative Mainstem Anoxia Forecast

The accuracy of ecological forecasts can be improved if outputs from different models are combined into a single prediction. This approach is used by meteorologists who rely on multiple models to forecast weather events such as storm tracks or front characteristics. A supplementary Chesapeake Bay mainstem anoxia forecast model has been developed, with the aim of improving the DO forecast accuracy. This new model is based on the relationship between anoxia for a smaller portion of the mainstem and Susquehanna River spring nitrogen and phosphorus loads, water temperature, and flow. Based on this model, 2007 summer anoxia would be the 5th worst, compared to the 11th worst predicted by the existing anoxic volume model. While this year's anoxic forecast does not incorporate results of the supplementary model, the new model suggests that the anoxic volume may be closer to the higher end of the predicted range of 0.87 to 1.91 km^3.

MINIMAL RECOVERY OF AQUATIC GRASSES EXPECTED

During 2006, many regions of the Bay experienced a significant reduction in aquatic grasses cover due to factors such as the dry spring conditions, an early summer rain event, and above average water temperatures in summer 2005. The 2007 aquatic grasses forecast indicates a small degree of recovery may occur in some regions (e.g. lower Potomac River), while other areas are likely to remain the same (e.g. Tangier Sound). The forecast is based on assessment of recent water quality data, historic aquatic grasses survey data, recent field observations, and in some cases, correlation analysis. Forecasts for three distinct locations of the Bay are provided here – northern Bay, lower Potomac River, and Tangier Sound (Figure 5) – and one other location, the Patuxent River, can be found on the supporting website (www.eco-check.org/forecast/chesapeake/).

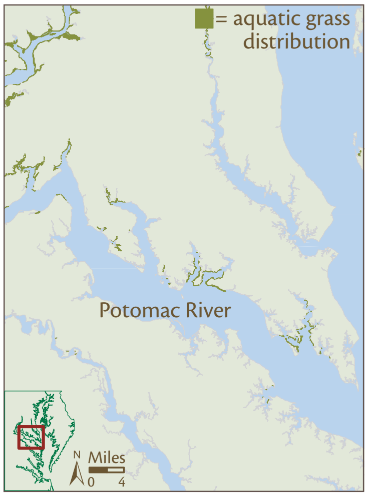
Northern Bay – No net change in area

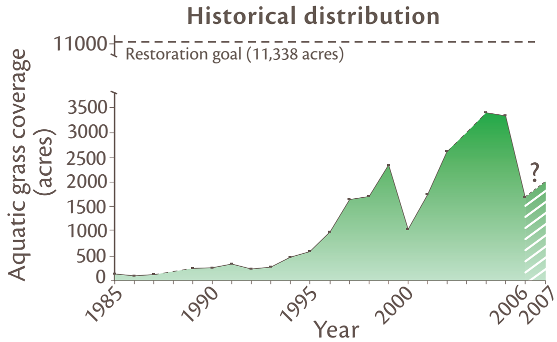


*Wild celery (*Vallisneria americana*) is one of the many species in the northern Bay.*

This forecast is based on the following observations: (i) below average winter and spring water temperatures that may slow spring growth; (ii) minimal potential habitat area (shallow shoals) for the aquatic grasses to expand into–aquatic grasses in this area are close to the restoration goal; and (iii) resilience of the large Susquehanna Flats meadow to events such as floods, meaning that a significant loss of aquatic grasses in this area is unlikely.

Lower Potomac River – A slight recovery (~400 acres) in area following major losses in 2006

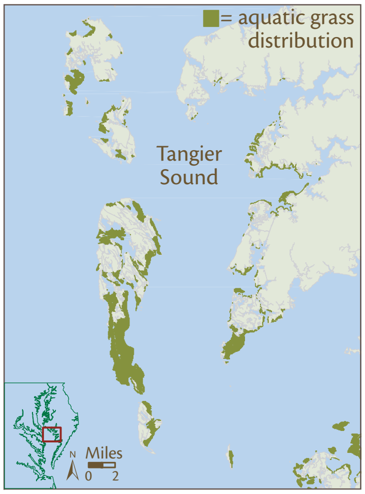


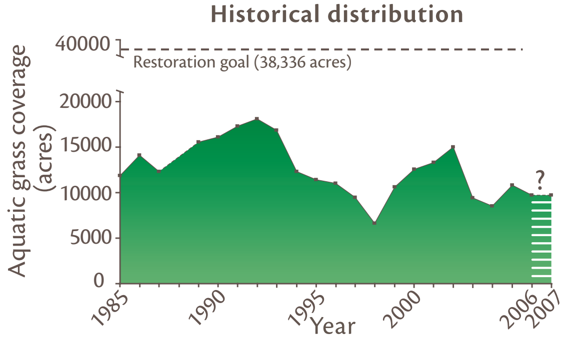


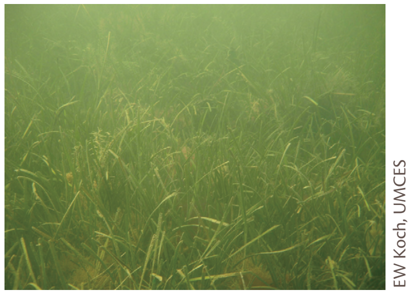
*Widgeon grass (*Ruppia maritima*) is a common species in the lower Potomac River.*

This forecast is based on the following observations: (i) the relationship between below fall-line nitrogen loads and aquatic grass cover–low nitrogen loads last year may lead to increased area; (ii) below average salinity levels, favoring recovery of freshwater species; and (iii) favorable levels of over-wintering widgeon grass (*Ruppia*) towards the mouth of the Potomac River.

Tangier Sound – No net change in area







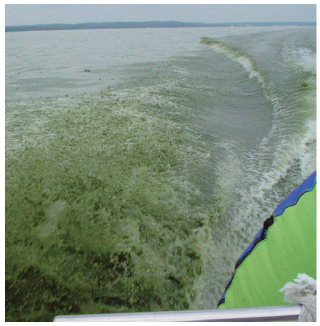
*Eelgrass (*Zostera marina*) is a dominant species in Tangier Sound.*

This forecast is based on the following observations: (i) below average, and in some cases record low, water clarity levels during winter and spring may be limiting light availability (loss due to poor water clarity unlikely as aquatic grasses are already restricted to shallow regions); and (ii) below average water temperatures that may slow spring growth rates.

Figure 5: Maps of 2006 aquatic grass coverage, historical distribution of aquatic grasses, and photos of representative species for each forecast location.

MODERATE POTOMAC RIVER HARMFUL ALGAL BLOOM

Blooms of the harmful algae *Microcystis aeruginosa* (a cyanobacterium) have occurred in the Potomac River for most summers since the 1960s. These blooms have had numerous ecological, economic, and human health implications and have been an impetus for major nutrient reduction programs. Consequences of these blooms depend largely on their scale (extent and duration) and intensity (cell density). Historic data shows that the scale and intensity of Potomac River HABs are variable from year to year (Figure 6). In some years (e.g. 2004) the scale of the bloom may be moderate but the intensity is high, while in other years (e.g. 1994) the scale may be high, but the intensity moderate.



Connie Goulet

Green prop wash of algal scum during a Potomac River HAB.

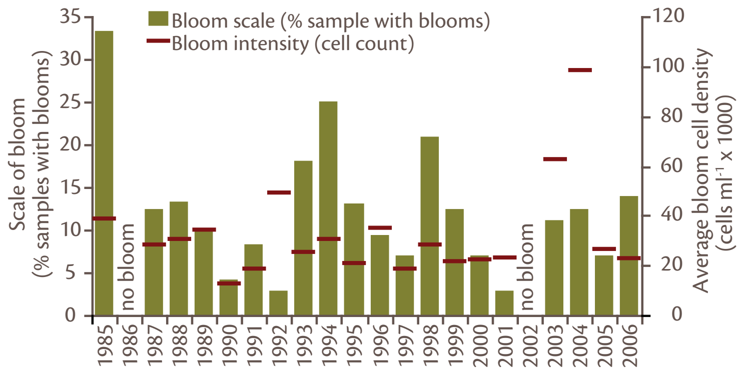


Figure 6: Historical Potomac River harmful algal bloom extent and intensity (mean bloom sample cell count).

Forecasting harmful algal blooms (HABs) enables managers to minimize potential effects of the bloom such as managing recreational risk due to possible algal-driven toxins. The main factors determining HAB occurrence in the Potomac River are nutrient availability, salinity, water temperature, and light availability. An overriding influence on bloom occurrences is river flow, most likely due to its effect on nutrient availability. Therefore, the forecast is based on a model that relates prior winter and spring plus previous year flow rates to the likelihood, onset period, duration, and extent of a bloom.

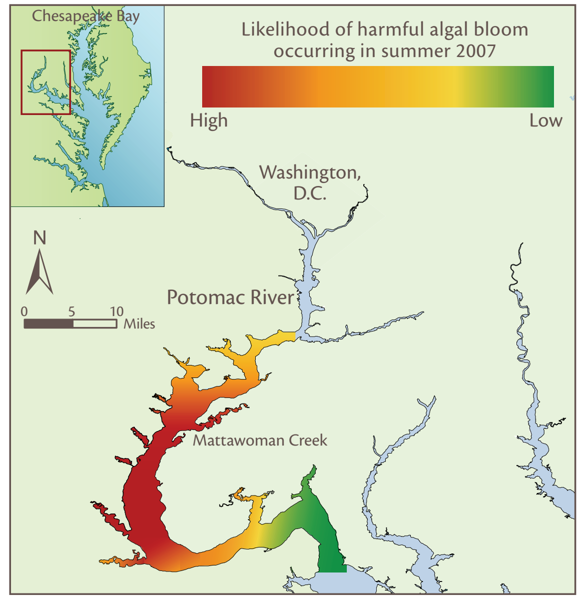


Figure 7: Likelihood of 2007 Potomac River HAB occurring.

As HABs have occurred in the Potomac River for all but two summers that had below average flows preceding them, there is a high (83%) likelihood that a *Microcystis* bloom will occur this summer (Figure 7). Potomac River flow rates were moderate in 2006 and for the winter and spring of 2007, resulting in a prediction of average bloom conditions (Table 1). The bloom is predicted to start in June (60% chance) or July (40%), last for one to two months, and extend between 10 to 20 miles. Based on similar summers preceded by comparable flow conditions (1990 and 1991), there is a low likelihood for detecting high cell counts (>100,000 cells ml^{-1}) and associated green algal surface scum this summer.

Table 1: 2007 Potomac River forecast for harmful algal bloom onset, duration, and extent.

Forecast	
Bloom condition	2007 forecast
Bloom onset	Early summer
Bloom duration	Moderate (1 to 2 months)
Bloom extent	Small to medium (10 to 20 miles)

This newsletter was produced by the Chesapeake Bay Program's Tidal Monitoring and Analysis Workgroup (TMAW). Susquehanna fall line nutrient loads provided by Joel Blomquist (USGS). Dissolved oxygen forecasts produced by David Jasinski (CBP-UMCES) and Ping Wang (CBP-UMCES). Aquatic grasses forecast produced by Peter Bergstrom (NOAA), Bill Dennison (UMCES), Lee Karrh (MD DNR), Jeni Keisman (CBP-UMCES), Ben Longstaff (EcoCheck), Bob Orth (VIMS), Nancy Rybicki (USGS), Dave Wilcox (VIMS), and Michael Williams (CBP-UMCES). Harmful algal bloom forecast produced by Peter Tango (CBP-USGS).

Newsletter prepared by:

Caroline Wicks and Ben Longstaff, EcoCheck (NOAA-UMCES Partnership)
Bill Dennison, University of Maryland Center for Environmental Science
David Jasinski, Chesapeake Bay Program-UMCES
Peter Tango, Chesapeake Bay Program - US Geological Survey

Further information at:

http://chesapeakebay.net/bayforecast.htm
www.eco-check.org/forecast/chesapeake/
www.eyesonthebay.net
www.vims.edu/bio/sav

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Current TMAW members and their affiliations:

University of Maryland Center for Environmental Science
Bill Dennison - Coordinator
David Jasinski
Caroline Wicks
Jeni Keisman
Michael Williams
Ben Longstaff

Maryland Department of Natural Resources
Ben Cole
Rebecca Raves
Renee Karrh
Bill Romano
Bruce Michael
Mark Trice

Old Dominion University
Daniel M. Dauer

Carlton Haywood
Claire Buchanan

USGS science for a changing world
Michael Koterba
Mary Ellen Ley
Jeff Raffensperger
Peter Tango

William & Mary VIMS Virginia Institute of Marine Science School of Marine Science
Ken Moore
Bob Orth

NOAA
Peter Bergstrom

ORC
Jamie Bosiljevac

MDE
Charlie Poukish

Versar Inc.
Roberto Llanso

DEQ Virginia Department of Environmental Quality Virginia Coastal Program
Rick Hoffman

Morgan
Rich Lacouture