In situ Surveys of Seagrass Habitat in the Northern Segment of the Barnegat Bay-Little Egg Harbor Estuary: Eutrophication Assessment

QUALITY ASSURANCE PROJECT PLAN

Prepared by Michael J. Kennish, Institute of Marine and Coastal Sciences, Rutgers University, New Brunswick, New Jersey

December 31, 2010

Revised February 1, 2011

Approved by: Donna Ringel 4/21/11
Donna Ringel, Quality Assurance Officer — date
U.S. EPA Region 2

Approved by: Barbara Spinweber 4/19/11
Barbara Spinweber, Project Officer — date
U.S. EPA Region 2

Approved by: Marc Ferko 4/12/11
Marc Ferko, Quality Assurance Officer — date
NJDEP Office of Quality Assurance

Approved by: Thomas Belton 4/11/11
Thomas Belton, Project Officer — date
NJDEP Office of Science

Approved by: Michael J. Kennish 4/6/11
Michael J. Kennish, Principal Investigator — date
Rutgers University

Approved by: Gregg Sakowicz 4/6/11
Gregg Sakowicz, Quality Assurance Officer — date
Rutgers University

Approved by: James M Vasslides 4/26/11
James Vasslides, Project Manager — date
Barnegat Bay Partnership

TABLE OF CONTENTS

QAPP DISTRIBUTION LIST

Signed copies of this Quality Assurance Project Plan (QAPP) and all subsequent revisions will be sent to the following individuals by electronic mail:

Barbara Spinweber, Project Officer, U.S. EPA, spinweber.barbara@epamail.epa.gov
Donna Ringel, Quality Assurance Officer, U.S. EPA Region 2, ringel.donna@epa.gov
Marc Ferko, Quality Assurance Officer, NJDEP, marc.ferko@dep.state.nj.us

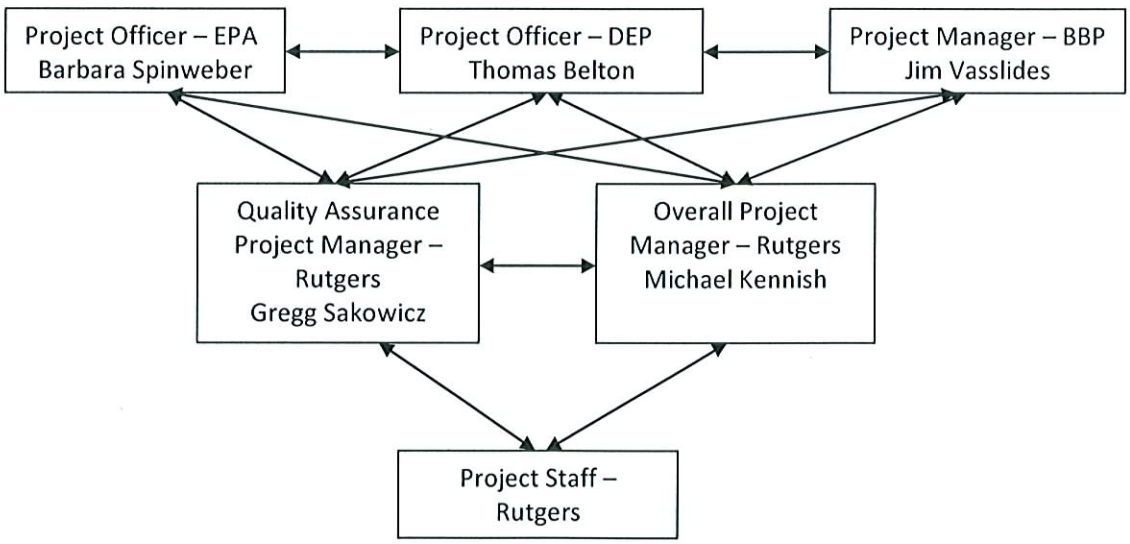
Thomas Belton, Project Officer, NJDEP, thomas.belton@dep.state.nj.us
Michael J. Kennish, PI/Project Manager, Rutgers Univ., kennish@marine.rutgers.edu
Gregg Sakowicz, Quality Assurance Manager, Rutgers Univ., sakowicz@marine.rutgers. edu
James Vasslides, Program Scientist, Barnegat Bay Partnership, jvasslides@ocean.edu

PROJECT DURATION: October 1, 2011-May 31, 2012

PROJECT ORGANIZATION:

Overall project management will be the responsibility of Dr. Michael J. Kennish. Dr. Kennish will oversee the collection of samples by technical staff and will be responsible for data analysis, biotic index development, and maintenance of the approved QA Project Plan. Gregg Sakowicz will provide quality assurance management, reviewing data acquisition and data analysis protocols, and ensuring compliance with all elements of the QA Project Plan.

Organizational Chart-Lines of Communication



ABSTRACT

We will conduct a two-pronged, *in-situ* study of the Barnegat Bay-Little Egg Harbor Estuary in 2011 to accomplish the following: (1) determine seagrass demographics in the northern segment of the estuary; and (2) document the presence/absence, areal cover, biomass, and shoot density of seagrass habitat across the entire estuary in conjunction with a related study funded by the New England Interstate Water Pollution Control Commission (NEIWPCC). The *in situ* surveys in the proposed project will delineate the demographic characteristics of mixed

seagrass beds (*Ruppia maritima* and *Zostera marina*) in the northern segment of the estuary during the June-November sampling period in 2011. Data collected in the project will be used to calculate a biotic index of condition for the northern segment. Water quality and biotic sampling data will be integrated in a GIS to identify hotspots of impaired water quality and eutrophication. State-of-the-art, targeted seagrass sampling will be conducted in the northern segment to accomplish these objectives using the protocols of the SeagrassNet approach that have been applied in other segments of the estuary. These protocols will be employed in the proposed project, as well as in the NEIWPCC project, to maintain consistency and data integration with previous seagrass surveys. We will follow verbatim the sampling, data management, data analysis and all other procedures mandated in the NEIWPCC project Quality Assurance Project Plan (QAPP).

STATEMENT OF PROBLEM

The Barnegat Bay–Little Egg Harbor Estuary is a shallow, lagoonal back-barrier system located along the central New Jersey coastline between 39°31' N and 40°06' N latitude and 74°02' W and 74°20' W longitude (Figure 1). It is a highly eutrophic estuary because of nutrient over-enrichment (Bricker et al. 2007; Kennish et al. 2007a, 2009; Kennish 2009). Major symptoms of eutrophication in this lagoonal system include low dissolved oxygen (in the northern segment), nuisance and toxic algal blooms, stressed submerged aquatic vegetation (SAV), heavy seagrass epiphytic overgrowth, loss of essential habitat (seagrass and shellfish beds), and declining fisheries (e.g., bay scallops and hard clams). Since 2004, seagrass condition in the estuary has declined (Kennish et al. 2008, 2009, 2010). For example, the aboveground and belowground biomass of seagrass in the estuary decreased by 50-87.7% over the 2004-2006 period (Kennish et al. 2007b, 2008, 2010), and seagrass habitat had yet to recover from this impacted condition through 2009 (Kennish et al. 2009, 2010). Results of seagrass sampling in 2009 indicate ongoing eutrophic responses, with the lowest seagrass biomass values recorded in the estuary since comprehensive *in situ* sampling of seagrass beds commenced in 2004. The decrease in seagrass areal cover during the 2004-2006 period, coupled to nutrient enrichment, eliminated habitat for bay scallops, hard clams (*Mercenaria mercenaria*), as well as many other benthic and demersal organisms. Blooms of the sea nettle (*Chrysaora quinquecirrha*), possibly coupled to increasing eutrophic conditions, have likewise escalated in the estuary in recent years. The aforementioned changes have been linked to changes in ecosystem structure and function and therefore pose a serious threat to the long-term health and integrity of the estuary.

PROJECT OBJECTIVES

Previous eutrophication assessment studies of seagrass in the Barnegat Bay-Little Egg Harbor Estuary have targeted eelgrass (*Zostera marina*) beds which are concentrated in the southern and central segments of the system (Kennish et al., 2007a, b, 2008, 2009, 2010). Aerial and *in situ* surveys by Lathrop et al. (2006) have shown conclusively that widgeon grass (*Ruppia maritima*) is the overwhelmingly dominant seagrass species in the northern segment, while

eelgrass is the predominant form in the southern and central segments. Hence, a priority data gap currently exists in the seagrass database for the northern segment of the estuary. The objective of this study, therefore, is to fill this data gap so eutrophication assessment of the seagrass habitat can be targeted estuary-wide. This work targeting the northern segment of the estuary is needed to holistically assess the eutrophication problem that continues to impact the ecology of Barnegat Bay-Little Egg Harbor, and to provide baseline data for ongoing assessment and ecosystem-based management of the entire system.

This project is part of a larger effort to determine estuarine biotic responses to the loading of nutrients across a gradient of upland watershed development and associated estuarine nitrogen loading, and identify key biotic responses across a variety of estuarine organisms by examining shifts in phytoplankton (blooms), benthic macroalgae, seagrass, seagrass epiphytes, and shellfish populations. Seagrass will be closely monitored across the study period to determine when numeric shifts occur in biomass, shoot density, blade length, and areal cover which will then be correlated with nutrient loading levels (determined in subwatershed areas) to document the threshold points and levels of biotic decline. They will also be examined and assessed for statistical validity and inclusion in index development for the 1989 to 2011 period.

APPROACH

The Barnegat Bay-Little Egg Harbor Estuary has been divided into three segments (north, central, and south) to assess biotic responses to nutrient loading; this segmentation of the estuary is based on north-to-south gradients in salinity, nutrient loading, watershed development, and other factors (Figure 1). The PI and his colleagues have collected six years of extensive water quality and biotic response data (to nutrient loading) in eelgrass (*Zostera marina*) beds located in the central and southern segments of the estuary (2004-2006, 2008, 2009, and 2010) to assess eutrophic condition (Kennish et al. 2007b, 2008, 2009, 2010). Similar data must now be collected in the northern segment that, taken together with data derived from a related study funded by the New England Interstate Pollution Control Commission (NEIWPCC) targeting the other two estuarine segments, will provide a census approach essentially generating databases covering the entire extent of the seagrass habitat resource in the estuary. Remote sensing data collected across the estuary in 2003 and 2009 by the Center for Remote Sensing and Spatial Analysis at Rutgers University supplements the *in situ* databases of Kennish et al. (2008, 2009, 2010) to provide a full synoptic view of seagrass distribution for the system. Therefore, the proposed project will play a key role in determining the overall eutrophic impact in the estuary.

We will use a two-pronged, *in-situ* study in 2011 to accomplish the following: (1) determine seagrass demographics in the northern segment of the estuary; and (2) document the presence/absence, areal cover, biomass, and density of seagrass habitat across the entire estuary in conjunction with a related study funded by NEIWPCC (Baker and Kennish 2010). For this project, we will follow verbatim all the protocols established by the NEIWPCC QAPP, which is attached (Baker and Kennish 2010). The *in situ* surveys in the proposed project will delineate the demographic characteristics of mixed seagrass beds (*Ruppia maritima* and *Zostera marina*) in the northern segment of the estuary during the June-November sampling period in 2011. State-

of-the-art, targeted seagrass sampling will be conducted in this segment of the estuary to accomplish these objectives using the protocols of the SeagrassNet approach (Short et al. 2002) adopted by Kennish et al. (2007a, b, 2008, 2009) for previous seagrass studies in the estuary. These protocols will be employed in the proposed project, as well as in the NEIWPCC project, to maintain consistency and data integration with previous seagrass surveys.

The seagrass beds targeted in the northern segment in this study have been identified through remote sensing and in situ sampling conducted in 2010. As in previous seagrass sampling conducted for the NEIWPCC project, not all seagrass beds will have an equal chance to be selected for sampling in the northern segment. However, the three most extensive seagrass beds in the northern segment have been identified and selected for this study and a transect sampling design (one transect per bed) established (Figure 2). We applied the same targeted sampling design for the NEIWPCC project, conducting comprehensive transect sampling of the major seagrass beds across the southern and central segments of the estuary, and therefore have maintained a consistent holistic sampling approach. This is the prevailing methodology used for seagrass sampling by the SeagrassNet program (Short et al., 2002).

Quadrat, transect, and hand sampling in the northern estuary will be conducted bimonthly at 10 equally spaced sampling stations along each of 3 transects during 3 sampling periods (June-July, August-September, October-November) in 2011 (Figure 2). Digital photographic images will also be taken with each seagrass sample at each site. Thus, a total of 90 seagrass samples will be collected at the 30 sampling stations in the northern segment of the estuary during the 2011 sampling period, including 90 quadrat samples and 90 core samples. Temporal and spatial variation in aboveground and belowground biomass, shoot density, blade length, seagrass epiphytic overgrowth, percent seagrass areal cover, and occurrence of bay scallops and hard clams will be recorded for both *R. maritima* and *Z. marina* habitat. The presence/absence and percent cover of macroalgae, macroalgae blooms, as well as the occurrence of phytoplankton blooms in the northern segment, will also be documented.

A 10-cm diameter, diver-deployed PVC corer will be used to collect *in situ* seagrass samples. Diver observations will be made at each sampling station to determine the occurrence and areal cover of seagrass and macroalgae, epiphytic infestation, and presence of bay scallops and hard clams. In addition, high resolution, underwater photographs will be used to validate diver observations. Sampling stations will be located with a Differential Global Positioning System.

Physicochemical data (temperature, salinity, pH, dissolved oxygen, and depth) will be collected at each sampling station using either a handheld YSI 600 XL datasonde coupled with a handheld YSI 650 MDS display unit, an automated YSI 6600 unit, or a YSI 600 XLM automated datalogger. Secchi depth will likewise be measured (using a Secchi disk) at each sampling station. Water quality data (other than Secchi depth) will be collected at a uniform depth (~10 cm) above the sediment-water interface using YSI datasondes. Water quality data collected by the NJ Department of Environmental Protection in the northern segment of the estuary during the study period will be used as secondary data. Included here are chlorophyll *a*, dissolved oxygen, Secchi depth, ammonia, nitrite plus nitrate, total nitrogen, phosphate, and total phosphorus. More

than 1000 physicochemical and biotic measurements will be compiled and analyzed in the project. Details of the protocols for field sampling, as well as laboratory and data analysis, in the proposed project can be found in Baker and Kennish (2010; Attached).

This project will be part of a larger effort to determine estuarine biotic responses to the loading of nutrients across a gradient of upland watershed development and associated estuarine nitrogen loading, and identify key biotic responses across a variety of estuarine organisms by examining shifts in phytoplankton (blooms), benthic macroalgae, seagrass, seagrass epiphytes, and shellfish (Baker and Kennish, 2010). Seagrass will be monitored across the study period to determine when numeric shifts occur in biomass, shoot density, blade length, and areal cover which will then be correlated with nutrient loading levels (determined in subwatershed areas by the US Geological Survey as part of the NEIWPCC project) to document the threshold points and levels of biotic decline. They will also be examined and assessed for statistical validity and inclusion in the index development for the 1989 to 2011 period.

NEIWPCC PROJECT LINK

It is important to note that the same biotic and water-quality parameters will be measured concurrently by the PI and his colleagues during 2011 in the southern and central segments of the estuary for the NEIWPCC project (see Baker and Kennish 2010). This project will provide critically important new data (for the northern segment of the estuary) that will augment the data collected in the NEIWPCC project. The results of the NEIWPCC project will be integrated with the results of the proposed work to yield a complete picture of seagrass demographics estuary-wide. Without having data for the northern segment of the estuary from the proposed work, a major data gap will exist for assessing eutrophication in the most heavily impacted portion of the system. Therefore, this is an important project for eutrophication assessment of the estuary.

Data collected in this project will also be used in development of a biotic index to define estuarine condition. By coupling *in situ* data from both projects, we will complete a comprehensive, estuary-wide SAV assessment for 2011 that will encompass all major seagrass beds in the system. In addition, data collected in this project will be assessed in the context of nutrient loading models being generated for this area of the estuary by the U.S. Geological Survey as part of the NEIWPCC project. This integration is a major strength of the proposed project. Outreach for the proposed study will also be conducted as part of the NEIWPCC project.

DELIVERABLES AND OUTCOMES

A draft report on results of this project will be submitted to Barnegat Bay Partnership on April 15, 2012, and a final report will be submitted on May 31, 2012 (Figure 3). This project will become part of an ecosystem-based study assessing biotic responses and biotic indicators of estuarine condition, particularly as they relate to the effect of watershed nutrient loading. A major outcome will be quantitative measures of the distribution, biomass, density, blade length, and areal cover of seagrasses in the northern segment of the estuary as well as the documentation

of other biotic responses such as the occurrence of nuisance and toxic algal blooms, and diminishing shellfish resources. To this end, data derived from the project will be incorporated into the development of a biotic index of ecosystem condition and numeric model for the Barnegat Bay-Little Egg Harbor Estuary that can be extended to other similar coastal lagoons in New Jersey and the mid-Atlantic region. Through the application of a comprehensive biotic index for the estuary, this project will help to provide a valid measure of eutrophic impairment and where remedial efforts must be focused to restore the system. The data will also be useful in the development of a nutrient management plan for the estuary and ultimately the formulation of nutrient criteria. Thus, the project will be important to State and Federal government environmental regulatory agencies. Finally, the data may be incorporated into an environmental monitoring strategy designed for long-term characterization of the State's estuarine resources.

Current conditions throughout the northern segment of the estuary will be well characterized. Data review, validation, and verification will be conducted when the raw data from the field and laboratory are examined in depth, and outcomes/benefits of the project goals can be assessed. The results of the nutrient loading data derived from the NEIWPCC project will be coupled to estuarine biotic response data to quantify spatial and temporal relationships between nutrient loading and biotic response/impact in the northern segment of the estuary. Therefore, a relationship between nutrient loading in subwatersheds and biotic conditions in the northern segment can be developed. A biotic index of condition will be calculated for the northern segment of the estuary. Water quality and biotic sampling data will be integrated in a GIS to identify hotspots of impaired water quality and eutrophication. The collection of biotic and water quality data in the field is planned through November 2011. An additional year of data acquisition (2012) in the northern segment would be valuable to validate the outcomes of this project. To this end, additional funding will be pursued for project support in 2012. These data will be useful for tracking spatial and temporal patterns of eutrophication in the northern segment and for determining if eutrophic conditions are improving, declining, or not changing in this area.

TIMELINE

This project will be conducted from October 1, 2010 to May 31, 2012. Figure 3 shows the timeline of events for the project. Field sampling will commence on June 1, 2011 and run through November 30, 2011. Laboratory analysis of samples will extend from June 1, 2011 through December 30, 2011. Data analysis will be conducted from January 1, 2012 to March 1, 2012. A draft report will be completed by April 15, 2012, and a final report submitted to the Barnegat Bay Partnership on May 31, 2012.

LABORATORY CERTIFICATION

The Rutgers University Marine Field Station (RUMFS) is certified (ID# 15024) by the NJDEP's Laboratory Certification Program. As per the NJDEP's Laboratory Certification Program, RUMFS is required to obtain and successfully pass proficiency test samples yearly in

order to maintain their certification to perform analysis for the parameters of pH, temperature, specific conductance, and dissolved oxygen.

PROJECT ORGANIZATION AND RESPONSIBILITIES

The PI on this project, Michael J. Kennish, is responsible for overseeing all aspects of the work, including sample and data collection, data analysis, quality assurance, and preparation of reports. A field team will be assembled to collect water quality and biotic data in the field under the supervision of Gregg P. Sakowicz. A research team will process field samples in the laboratory. A database manager/statistician will be responsible for data processing and data management under the direction of the PI. All protocols of the NEIWPCC QAPP will apply to this project.

REFERENCES

Baker, R. J. and M. J. Kennish. 2010. Assessment of nutrient loading and eutrophication in Barnegat Bay-Little Egg Harbor, New Jersey in support of nutrient management planning. Quality Assurance Project Plan to the New England Interstate Water Pollution Commission, Lowell, Massachusetts.

Bricker, S. B., B. Longstaff, W. Dennison, A. Jones, K. Boicourt, C. Wicks, and J. Woerner. 2007. Effects of Nutrient Enrichment in the Nation's Estuaries: A Decade of Change. NOAA, National Ocean Service, Special Projects Office and National Centers for Coastal Ocean Science, Silver Spring, Maryland, USA.

Kennish, M. J., S. B. Bricker, W. C. Dennison, P. M. Glibert, R. J. Livingston, K. A. Moore, R. T. Noble, H. W. Paerl, J. M. Ramstack, S. Seitzinger, D. A. Tomasko, and I. Valiela. 2007a. Barnegat Bay-Little Egg Harbor Estuary: case study of a highly eutrophic coastal bay system. *Ecological Applications*, 17(5) Supplement: S3-S16.

Kennish, M. J., S. M. Haag, and G. P. Sakowicz. 2007b. Demographic investigation of seagrasses in the Barnegat Bay-Little Egg Harbor Estuary with assessment of potential impacts of benthic macroalgae and brown tides. Technical Report, Institute of Marine and Coastal Sciences, Rutgers University, New Brunswick, New Jersey. 366 p.

Kennish, M. J., S. M. Haag, and G. P. Sakowicz. 2008. Seagrass demographic and spatial habitat characterization in Little Egg Harbor, New Jersey, using fixed transects. *Journal of Coastal Research,* SI 55: 148-170.

Kennish, M. J. 2009. Eutrophication of mid-Atlantic coastal bays. *Bulletin of the New Jersey Academy of Science* 54: 5-12.

Kennish, M. J., S. M. Haag, and G. P. Sakowicz. 2009. Assessment of Eutrophication in the Barnegat Bay-Little Egg Harbor System: Use of SAV Biotic Indicators of Estuarine

Condition. Technical Report, New Jersey Department of Environmental Protection, Trenton, New Jersey. 73 pp.

Kennish, M. J., S. M. Haag, and G. P. Sakowicz. 2010. Seagrass decline in New Jersey coastal lagoons: a response to increasing eutrophication. In: Kennish, M. J. and H. W. Paerl, (Eds.), Coastal Lagoons: Critical Habitats of Environmental Change. Taylor and Francis Publishers, Boca Raton, Florida, pp. 167-201.

Lathrop, R. G., P. Montesano, and S. Haag. 2006. A multi-scale segmentation approach to mapping seagrass habitats using airborne digital camera imagery. *Photogrammetric Engineering and Remote Sensing* 72: 665-675.

Short, F. T., L. J. McKenzie, R. G. Coles, and K. P. Vidler. 2002. SeagrassNet Manual for Scientific Monitoring of Seagrass Habitat. QDPI, QFS, Cairns. 56 pp.

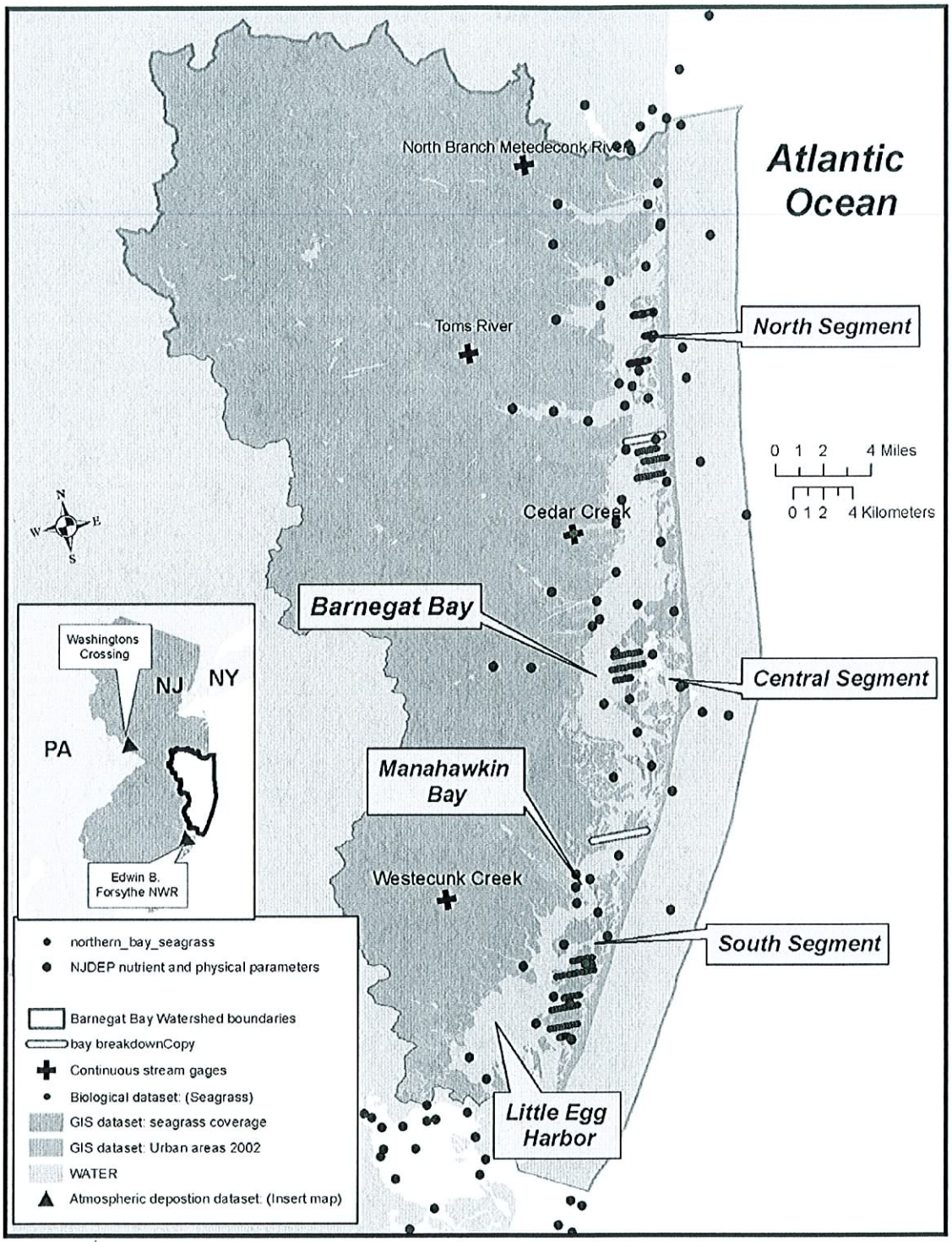


Figure 1. Barnegat Bay-Little Egg Harbor Estuary showing the north, central, and south segments of the study area and sampling transects.

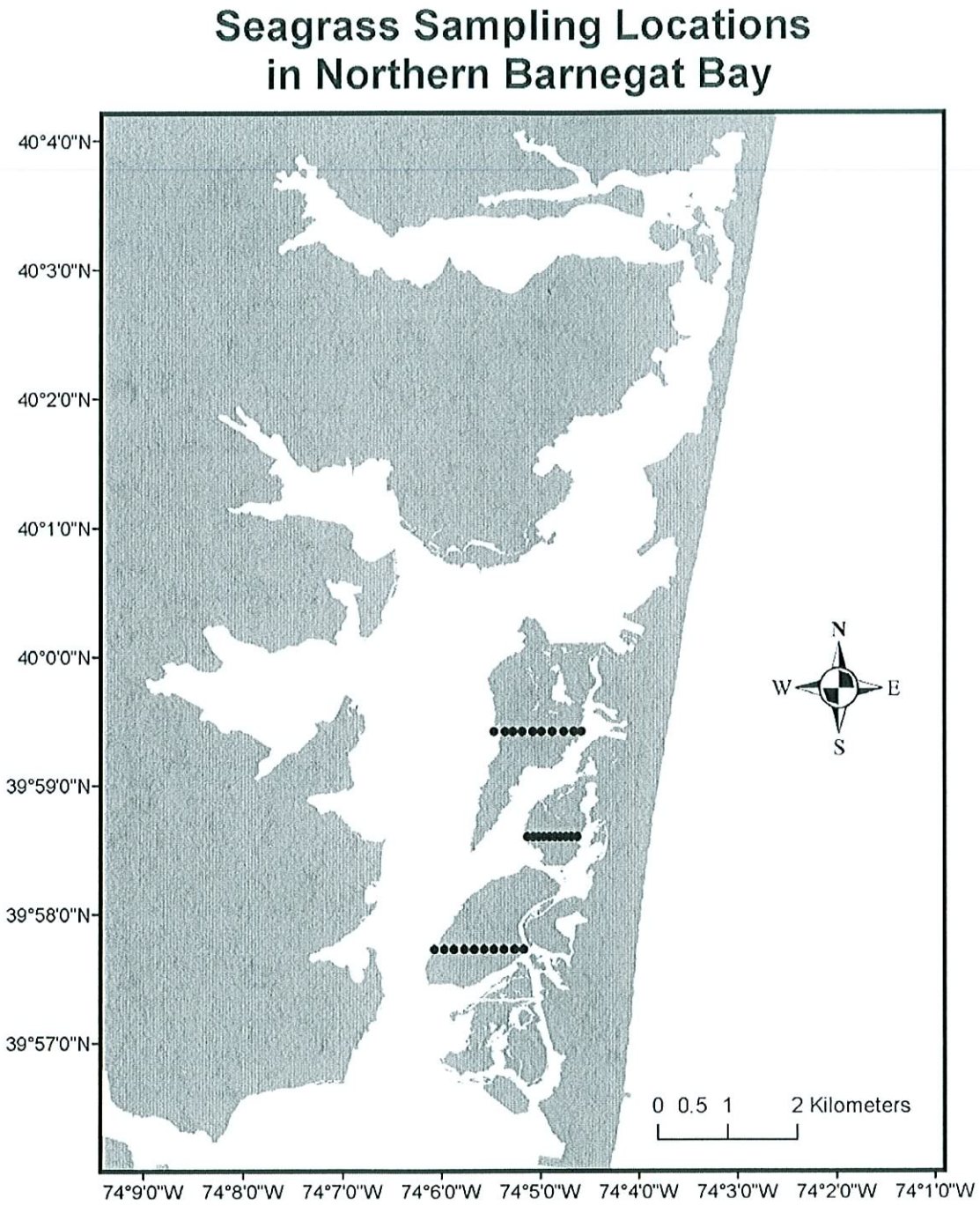


Figure 2. Sampling transects and stations in widgeon grass beds located in the northern segment of the Barnegat Bay-Little Egg Harbor Estuary.

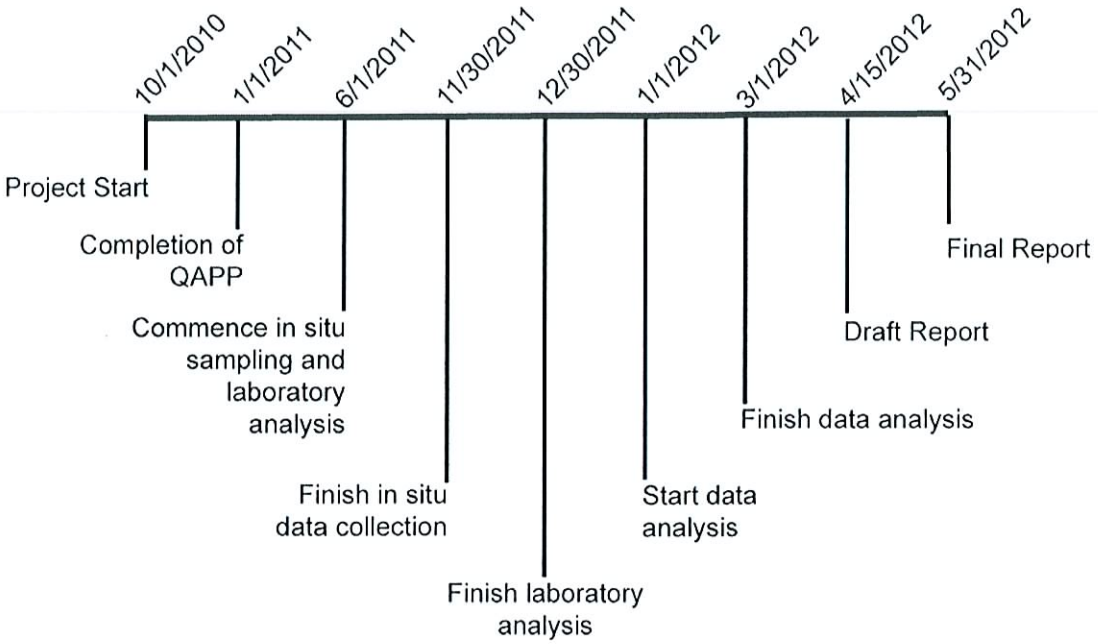


Figure 3. Timeline of events for the proposed project.