

**Channel Usage Research and Analysis – Phase II**

FINAL REPORT  
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Submitted by

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In cooperation with

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## EXECUTIVE SUMMARY

In 2014, Cambridge Systematics, Inc. and Greenman Pederson, Inc. (the “research team”) undertook research on alternative methodologies to count and classify vessels on New Jersey’s Marine Transportation System. During the summers of 2016 and 2017, the research team undertook a second phase of data collection with a goal of continuing to test field data collection methodologies under a wider range of field conditions. Another objective of the second phase of research is to assist NJDOT in developing a sustainable and consistent process for collecting data on state-maintained channels.

The research approach consisted of the following steps:

- The research team collected data in the field at six locations along coastal regions of New Jersey;
- The research team also intended to investigate the impact of factors such as weather and timing of high and low tides on use of channels; and
- The research team conducted a literature search to investigate options for management and reporting tools for entering, organizing and maintaining channel usage data and for producing summary reports of vessel counts by classification.

The field tests included manual observations taken from shore vantage points (for narrower channels) and manual observations from a boat positioned in the center of a wide channel.

Field data collection on shore vantage points was conducted from sunrise to sunset (6:00 AM to 8:00 PM) on three Saturdays. Field data collection from boats was conducted from approximately 7:30 AM to 6:30 PM due to restricted rental hours and the need to safely navigate a boat from a docking location to the field observation location.

The field data collection yielded the following results:

- **There was no difference in data accuracy between manual data collection from shore and from a boat.** The locations chosen for observation from boats were found during pre-survey reconnaissance to be too wide for an observer with binoculars to see across the entire channel. A boat positioned in the center of channel allowed two observers to observe the entire channel, one facing each direction. Both methods produced similar levels of accuracy.
- **The wider channels that could only be counted by personnel located on a boat are both more logistically complex and more expensive to survey.** Wider channels required two personnel per shift and advance rental of a boat. The boat rental reservations were made for a non-holiday weekend to reduce costs and allow for rentals from marinas located closer to the count locations. If NJDOT desires to regularly count wide channels on holiday weekends, the Department may want to consider providing the contractor with access to a boat or allow substantial increased costs to cover the holiday weekend boat rental costs.

- **Manual counts from a shore vantage point or from a boat appear to be the two most reliable and straightforward methodologies for conducting counts.** The research team did not encounter any situations where another methodology would be more reliable, economical or logical.
- **More information is needed regarding variables that could affect counts of vessels by class.** Over two seasons, the research team encountered nearly uniform conditions that were ideal for boating (sunny days with minimal to moderate wind of 5 to 10 m.p.h.), even though the field data collection days were chosen weeks in advance. These conditions resulted in a sample of counts that were most likely on the high end of the range of channel use for any given channel, compared to the range of observations that might be encountered if vessel counts were collected on every weekend day over an entire summer. Aside from weekend vs. weekday boating activity, weather is among the variables most strongly correlated with daily vessel counts. The team has conducted research into potential variables that affect use of public and private vessels; these findings are presented in the Literature Review section of this report. However, since ideal weather conditions occurred uniformly throughout the project's data collection activities drawing conclusions about how different weather variables play a role in channel utilization cannot be made within this report. Additionally, contingency plans to avoid poor weather conditions was considered and implemented as part of this effort. In the future gathering channel data on poor weather days may be of value to examine how different weather variables impact channel usage.

As a result of the information gleaned from the literature search and experience gained in the pilot field tests, the research team has the following recommendations. NJDOT should:

**Develop a procedure for collecting counts on a regular schedule.** The procedure should be tailored to the geography surrounding the channel (which will affect how the data are collected), the channel's function in New Jersey's waterway system (a corollary to roadway functional classification that may be related to use and economic value), and relationship to the maintenance dredging program (which may determine the need to do before/after counts).

**Continue to collect data in a wide range of field conditions** so that, over time, NJDOT will have sufficient data to run regression models to determine (a) which variables affect the accuracy and precision of each count methodology (for example weather), and to what extent, and (b) which variables affect the use channels by vessel type. Additional data also can help NJDOT determine how often count and classification data need to be collected for each channel or type of channel in order for the samples to provide statistically-valid data. A list of specific variables to test is contained in the Conclusions and Recommendations section.

**Develop a set of factors to correct for variables that affect vessel counts and classifications** so that count and classification data can be normalized depending on when, where and under what weather conditions the count was conducted. In order to



develop these factors, NJDOT will need to conduct additional tests in a wide range of field conditions, on different days of the week and at different points throughout the year.

**Implement a Marine Transportation System data collection program** based on approved methodologies, procedures, collection techniques, and a proposed channel collection schedule.

All of these recommendations are focused on improving NJDOT's ability to collect channel count and classification data. However, NJDOT also should identify what other information in addition to channel count and classification data is needed to support asset management-related decision making on New Jersey's Marine Transportation System.

## **BACKGROUND**

The NJDOT Office of Maritime Resources (OMR) emergency response to Superstorm Sandy highlighted the importance of developing an asset management system to more efficiently manage New Jersey's Marine Transportation System. Storm response efforts included a preliminary economic value and vessel usage evaluation for most of the State's channels. Vessel usage was determined in part by compiling data on the availability of waterway services such as slips per marina per channel, residential docks per channel, boat ramps per channel, etc. However, usage is known to vary depending on numerous factors including but not limit to: weather, time of year, origin/destination, size and type of vessel, and availability of alternative routes. As a result, actual vessel count data is required in order to validate existing assumptions and provide a more defensible assessment of actual channel usage.

## **OBJECTIVES**

The primary objective of this research is to help NJDOT develop and implement a reliable, repeatable, and verifiable method or SOP (Standard Operating Procedure) to collect vessel count and classification information by time of day. The research involved field tests of several approaches that could be applicable to a broader statewide effort to collect vessel count information utilizing the selected method on approximately 214 state channels within the state's Marine Transportation System.

The study team was charged with collecting channel usage and classification data on a representative sample of the 214 state channels using a variety of methodologies so that results can be compared and guidance can be provided for future data collection efforts.

## **INTRODUCTION**

In 2014, Cambridge Systematics, Inc. and Greenman Pederson, Inc. (the "research team") undertook research on alternative methodologies to count and classify vessels on New Jersey's Marine Transportation System. During the summer of 2016, the research team undertook a second phase of data collection with a goal of continuing to test field data collection methodologies under a wider range of field conditions. This report summarizes the results of the second round of field tests and research on how NJDOT

could set up an ongoing process for collecting and managing vessel count and classification data.

## **SUMMARY OF WORK PERFORMED**

At the direction of NJDOT, the research team conducted field data collection efforts and researched factors that contribute to fluctuations in vessel count by classification. The following sections provide a detailed review of the activities and analyses performed throughout this effort.

## **FIELD DATA COLLECTION**

### **Preparation for Data Collection Effort**

- The project team met with NJDOT Office of Maritime Resources to discuss the objectives for the 2016 counts and potential channels to conduct counts. The project team visited the proposed channels to determine whether they were able to count vessels from the shoreline or whether a rental boat would be required. The project team proposed a list of five channels to count from the shoreline and one channel to count from a boat positioned in the center of the channel.
- The research team and NJDOT Office of Maritime Resources coordinated with and notified local officials and police regarding the vessel counts. All were provided with an NJDOT project authorization letter as well as 24/7 contact information.
- The research team organized a training session for staff who would be conducting the field counts to familiarize staff with count equipment and procedures and to review vessel classification categories. The training session was intended to improve reliability of data collection and reduce discrepancies in vessel classification data, particularly given the subjective nature of the vessel classification scheme. Staff were trained to classify vessels using a standardized set of categories, and photos of examples of vessels in each category were provided to the counters as part of their field manuals.
- Vessel classification counts were performed from land on Saturday, May 28<sup>th</sup>, 2016, Saturday, June 18<sup>th</sup>, 2016, Saturday, July 2<sup>nd</sup>, 2016, and Saturday, May 27<sup>th</sup>, 2017 from 6:00 AM to 8:00 PM. One channel was counted from a boat on Saturday, June 18, 2016 from 7:30 AM to 6:30 PM due to the need to pick up the rental boat and navigate it to and from the survey location.

Characteristics of the count locations are summarized in Table 1.

### **Field Notes**

There were no major issues encountered during any of the four Saturday counts. The weather conditions all count days were sunny and averaged 80 degrees.

Table 1 – Summary of Count Locations and Methodologies

Location	Days and Hours Counted	Number and Position of Enumerators
Double Creek Mainland, Township of Barnegat, Ocean County	6:00 AM to 8:00 PM Saturday, May 28th, 2016	Two (2) enumerators working in split shifts from 6:00 AM to 1:00 PM and 1:00 PM to 8:00 PM utilizing electronic count boards and binoculars
St. George's Thorofare, Brigantine City, Atlantic County	Saturday, June 18th, 2016	
Ocean Port Creek, Oceanport Borough, Monmouth County	Saturday, July 2nd, 2016	
Gunners Ditch, Brick, Ocean County	Saturday, May 27th, 2017	
Metedeconk River, Brick Township, Ocean County		
Toms River, Berkeley Township, Ocean County	7:30 AM to 6:30 PM Saturday, June 18th, 2016	Two (2) enumerators working for the entire count period from a Skiff boat anchored in the channel

**Double Creek Mainland**

The Double Creek Mainland is located in Barnegat Township, Ocean County. The channel runs parallel to the shoreline beginning at the Barnegat on the Bay docks, traversing all the way to the East Bay Avenue Bridge.

Field staff conducted two (2) counts from the Barnegat Municipal Dock/Pier. The first count was conducted north of the boat ramp and the second was south of the boat ramp. This ensured that all vessels, including the ones being launched from the boat ramp, were included in the count. The staff counted all vessels utilizing an electronic count board and binoculars from the two (2) story gazebo located near the water.

**St. George's Thorofare**

St. George's Thorofare is located in the City of Brigantine, Atlantic County. The channel connects directly to Absecon Inlet across from Atlantic City. There is a designated safe

harbor refuge in St. George's Thorofare Bay for vessels to anchor during storms, there are private docks and slips in the Bay, and the Bay is a popular destination for day boaters from around the region, including tourists who navigate personal watercraft rented in Atlantic City across Absecon Inlet to the Bay. Brigantine Beach, where the counts were conducted, is a popular recreation area where personal vehicles are allowed on the beach. A mix of fishers, sun bathers, and boat watchers congregate on the beach.

Vessels using St. George's Thorofare were counted from Brigantine Beach at the mouth of the Thorofare. The staff counted all vessels utilizing an electronic count board for this channel due to the accessibility and distance from the beach to the channel, which was approximately 100 feet. A handful of pictures were taken of large commercial pontoon or cruising vessels that did not fit into the predetermined categories.

### **Ocean Port Creek**

The Ocean Port Creek channel is located in Oceanport Borough, Monmouth County. The channel runs north from the County Route 11, Oceanport Avenue Bridge to Seven Bridges Road Bridge then connects with Town Neck Creek, Blackberry Creek and Oceanport Creek Entry channels.

Field staff conducted counts from a cul-de-sac at the end of Milton Avenue, on the south side of the bridge at Seven Bridges Road. The staff counted all vessels utilizing an electronic count board. The staff noted that the channel was not very busy and due to the low clearance at the bridge that most vessels were small motor boats or personnel water craft.

### **Gunners Ditch**

The Gunners Ditch channel is located in Brick Township, Ocean County. Gunner's Ditch and the parallel Intracoastal Waterway Channel function as north-south connectors, with the Metedeconk River, Beaver Dam Creek, Bay Head Harbor, and the Manasquan River (via the Point Pleasant Canal) to the north and Barnegat Bay to the south.

Field staff conducted counts from Traders Cove Marina, just south of Gunners Ditch. The staff counted all vessels utilizing an electronic count board and binoculars due to the sight distance from the marina, which was approximately 2,400 feet or 0.47 miles. Field staff noted that the Gunners Ditch channel appeared to get more use than the Intercostal Waterway channel. In the 2014 counts, a local resident told a member of the study team that most boaters avoid using channels with a significant U.S. Coast Guard presence. The staff also observed on a few occasion a small motor boat towing small non-motorized sail boats. When this was observed, all vessels were counted individually.

### **Metedeconk River**

The Metedeconk River channel is located in Brick Township, Ocean County. The channel serves as an east-west connection between the Upper Metedeconk River, Beaver Dam Buoy and Gunners Ditch channels.

Field staff conducted counts from the end of Tilton Road, on the south side of Metedeconk River. The staff counted all vessels utilizing an electronic count board and binoculars due to the sight distance to the channel. The field staff noted that the location was consistently busy most of the day, possibly due to the presence of an on-site active sailing school.

### **Toms River**

The Toms River channel is located in Berkeley Township, Ocean County. The channel, lined with beaches, marinas, and yacht clubs, measures approximately 5.5 miles in length and runs east from Mathis Plaza Park to the Intercostal Waterway Channel.

Field staff, consisting of two (2) staff members, conducted counts from a 16-foot Skiff rental boat anchored at the mouth of the river just north of the channel. Due to the restricted rental hours and the need to safely navigate a boat from a docking location to the field observation location, the count was performed from 7:30 AM to 6:30 PM. The field staff noted that due to wind in the late afternoon waters were very choppy and a larger boat should be secured for the next count. It was also noted that a sailboat school was active in the mouth of the river throughout the mid-day hours, which may have in turn produced more vessels. The sailboats were not counted unless they crossed the vessel count line. Most of the sailboats stayed west of the count line. The staff also noted on a few occasions a small motor boat towing small non-motorized sail boats. When this was observed, all vessels were counted individually. The channel did not have any wake restrictions so boats were often traveling quite fast. There was a marina on the south side of the channel that had quite a bit of activity.

### **Summary of Data Collected**

The following tables summarize the total daily vessel volume, peak boating hours and vessels by classification for each count location. The peak hour was determined by totaling both directions for each hour counted and identifying the highest volume.

The data in Tables 2 and 3 do not reveal any discernible pattern in channel use by date or time of day.

In Double Creek Mainland channel, the number of vessels observed north of the launch was almost identical on Saturday of Memorial Day weekend (May 28) and Saturday, June 18 (a non-holiday weekend), at around 190 total vessels. On July 2 however (the Saturday before July 4), the number of vessels observed was significantly larger with a total of 247 boats. South of the launch however, Memorial Day weekend saw the fewest vessels, while a non-holiday weekend (June 18) saw similar figures as July 2.

St. George's Thorofare had the highest count on Saturday, June 18 (a non-holiday weekend), Ocean Port Creek had the highest count on Memorial Day weekend (May 28), and Gunner's Ditch recorded the highest count on July 2 (the Saturday before July 4).

Similarly, there was no pattern in the peak hour at any location (across dates) or on any one date (across locations).

Table 2 – Daily Total Volume Per Channel

Channel	5/28/2016	6/18/2016	7/2/2016	5/27/2017
Double Creek Mainland	190	188	247	189
North of launch	163	199	198	161
South of launch				
St. George's Thorofare	362	443	413	174
Ocean Port Creek	175	130	131	114
Gunner's Ditch	1361	1374	1503	1086
Metedeconk River	-	1376	-	-
Toms River	-	1099	-	-

Table 3 – Daily Peak Hours and Volumes by Channel by Date

Channel	5/28/2016	6/18/2016	7/2/2016	5/27/2017
Double Creek Mainland				
North of launch	12:00 - 1:00 PM (33)	1:00 - 2:00 PM (26)	10:00 - 11:00 AM (33)	2:00 - 3:00 PM (24)
South of launch	11:00 - 12:00 PM (28)	1:00 - 2:00 PM (28)	3:00 - 4:00 PM (33)	1:00 - 2:00 PM (23)
St. George's Thorofare	3:00 - 4:00 PM (68)	1:00 - 2:00 PM (72)	4:00 - 5:00 PM (84)	10:00 - 11:00 AM (35)
Ocean Port Creek	12:00 - 1:00 PM (24)	5:00 - 6:00 PM (22)	1:00 - 2:00 PM (34)	12:00 - 1:00 PM (21)
Gunner's Ditch	2:00 - 3:00 PM (187)	3:00 - 4:00 PM (188)	2:00 - 3:00 PM (208)	11:00 - 12:00 AM (144)
Toms River		2:00 - 3:00 PM (134)	-	-
Metedeconk River	-	3:00 - 4:00 PM (190)	-	-

The classification summary of the data from June 18, 2016 indicates that small motorboats made up the highest percentage of vessels for each channel with the exception of St. George's Thorofare showing the motorized personal watercraft class being the dominant group. The most likely reason for the high percentage of personal

water craft is directly related to the close vicinity to Brigantine Beach. The second largest class of vessels at most locations was the motorized personal water craft. Exceptions to this trend however were evident at Double Creek Mainland and Toms River, where medium motor boats were the second largest observed class.

The following table shows the observed number of vessels counted by classification at each count location.

Table 4 – Vessel Counts by Classification by Channel

Channel	Small Motor boat	Medium Motor boat	Large Motor boat	Small Sail boat	Medium Sail boat	Large Sail boat	Personal Water Craft Non-Motorized	Personal Water Craft Motorized
Double Creek Mainland: North of launch	615	52	1	59	43	0	9	35
Double Creek Mainland: South of launch	509	46	1	56	40	2	31	36
St. George's Thorofare	649	67	9	2	24	1	40	600
Ocean Port Creek	348	9	0	0	0	0	75	118
Gunner's Ditch	3552	798	3	21	12	0	22	916
Toms River	508	316	4	22	84	4	10	151
Metedeconk River	842	198	11	26	20	0	15	264

## VARIABLES THAT AFFECT VESSEL COUNTS

Table 5 below shows the variables that should be collected initially as part of a channel program. Those variables include specific days and months of the year, weather forecasts and actual weather conditions, marine tides and amount of daylight. In addition to the total number of vessels, these variables may also affect the types of vessels out on the water. For example, certain variables and conditions may affect the propensity to use a sailboat as opposed to a powerboat, while others may lead to increased recreational usage as opposed to commercial boating.

The statistical significance and thresholds for each of these variables will need to be determined in the future when more data are available to run a regression. Some variables could be dropped if they are found to be unrelated to vessel counts by classification.

Table 5 – Variables that May Influence Vessel Counts by Classification

Variable	Description	Influences
Day of the week	Indicate Monday-Sunday	<ul style="list-style-type: none"> <li>• Saturday and Sundays have highest traffic</li> </ul>
Month	Indicate month	<ul style="list-style-type: none"> <li>• Month of August is peak of vacation season, particularly for vacation homeowners.</li> <li>• Weekdays in August may have higher traffic than weekends in other months.</li> <li>• Some schools in New Jersey, Pennsylvania, New York, and other states may begin in last two weeks of August, so first two weeks are peak of peak.</li> <li>• Water temperatures are warmest in August</li> </ul>
Holiday	Indicate any of the following: <ul style="list-style-type: none"> <li>• Memorial Day weekend (Saturday, Sunday or Monday)</li> <li>• Labor Day weekend (Saturday, Sunday, or Monday)</li> <li>• 4<sup>th</sup> of July (one day)</li> <li>• Weekdays in the week of 4<sup>th</sup> of July</li> </ul>	<ul style="list-style-type: none"> <li>• Higher volumes may be observed on holiday weekends, on average</li> <li>• Week of 4<sup>th</sup> of July (two weekends plus week in which July 4 falls) is a peak vacation week</li> <li>• Higher than average weekday volumes may be observed on weekdays following Memorial Day Monday and Labor Day Monday</li> </ul>



Variable	Description	Influences
	<ul style="list-style-type: none"> <li>• Weekends before or after 4<sup>th</sup> of July (Saturday or Sunday)</li> <li>• Weekdays in the weeks after Labor Day or Memorial Day</li> <li>• Weekends after Labor Day or Memorial Day (Saturday or Sunday)</li> </ul>	
Weather Forecast	<ul style="list-style-type: none"> <li>• Chance of precipitation after sunrise</li> <li>• High temperature forecast</li> </ul>	<p>Forecasts of precipitation, particularly late in the day, can discourage people from boating. Commercial vessels may not be affected.</p> <p>High temperature forecasts below a certain threshold may impact use of powerboats more than sailboats.</p>
Actual weather conditions	<ul style="list-style-type: none"> <li>• Precipitation</li> <li>• Small craft advisory issued</li> <li>• Peak wind velocity</li> <li>• Air temperature</li> <li>• Water temperature</li> </ul>	<p>Precipitation or high winds can discourage people from boating.</p> <p>Sailboats are less used on days with very little wind.</p> <p>Low temperatures may impact use of power boats more than sailboats</p>
High and Low Tides	<ul style="list-style-type: none"> <li>• Time of high tide</li> <li>• Time of low tide</li> </ul>	<p>Certain channels might be more attractive to powerboats or commercial fishing close to high tide and may be unnavigable or less safe at low tide</p>
Length of day	<ul style="list-style-type: none"> <li>• Hours of daylight</li> </ul>	<p>Earlier in the season, people may stay out longer on their boats to take advantage of daylight hours, or they may be more willing to take the boat out later in the day, resulting in more traffic.</p>

Additional factors that may affect the counts in certain vessel classifications include:

- a) Channel depth;
- b) Channel width;

- c) Presence of vertical clearance constraints and obstructions, including movable and fixed bridges;
- d) Proximity to watercraft access points;
- e) Presence of boating schools and other institutions or events that could attract or restrict channel usage.

## **RECOMMENDATIONS ON DATA COLLECTION PROCEDURE**

As discussed in earlier phases of this research, there are several prerequisites to implementing a robust data collection effort:

NJDOT should develop a channel classification scheme that would take the following attributes into account:

- The channel's geometry, including depth and width;
- The presence of vertical clearance constraints and obstructions, including movable or fixed bridges;
- The presence or absence of a publicly-accessible vantage point for conducting manual or video counts;
- Whether the channel is in a low/no-wake zone or in a open water?
- The channel's function in the state's marine transportation system (e.g., is the channel the access point to a watershed with a large population of vessels, is it a connector between two bays, is it on an important route to access an inlet to the Atlantic Ocean or a mooring field that is a place of refuge in a storm, and so on); the state does not currently have a specific channel function/classification- but future research and continued vessel count usage will contribute to this information.
- The population of and types of vessels docked in the channel's watershed or in watersheds that use the channel to access inlets and other important destinations; and
- The share of transient vs. resident vessels using the channel.

NJDOT could identify the approximate lat/long coordinates of count locations and associated the attributes above to these points. The points can then, in turn, be associated with a georeferencing system for state-maintained channels, using either linear or using polygon representations of navigable waterways. This system could build upon the existing georeferencing system implemented by the U.S. Army Corps of Engineers for federal channels.

Based on the method of data collection employed by the project team, NJDOT should utilize the following tools and corresponding count procedure to perform collection, management and reporting of channel usage data. This process takes into account best practices identified in the previously conducted literature review, and employed by other organizations including state Departments of Transportation, U.S. Coast Guard, local universities, as well as cost effectiveness.

Once the channels are identified and classified, NJDOT should establish a procedure for collecting vessel count and classification data on state-maintained channels. Based on this research, there are several basic steps in the procedure:

**1) Determine the channels to be counted each season.** Typically, this should happen in the winter months. The most heavily used channels should be counted frequently to establish a baseline or “control” case to compare other channel counts to adjust for seasonal or weather-related variations. Channels either that are slated to have maintenance projects or that have recently undergone a maintenance-dredging project should be counted in years before and after the project is completed. Then, channels should be counted on a rotating basis, perhaps every five to seven years.

*Key steps:*

- *Request initial list of preferred list of channels to be surveyed from NJDOT Office of Maritime Resources (OMR).*

**2) Preview each site using available online resources, and then conduct a site visit to confirm count location and methodology.** The preview can help determine the most effective count methodology (see Table 6) and where there may be suitable shoreline vantage points. A channel’s width will dictate whether a single person can accurately observe vessel movements across the entire channel or whether a person can discern vessels by classification from video recorded by a temporary or permanent camera. If there is a suitable shoreline vantage point, a person can observe vessel movements live, or there may be a secure location to install a permanent or temporary camera to record video. If the channel is too wide and/or if there is not a suitable (and safe) shoreline vantage point, the count will need to be taken from a boat.

*Key steps:*

- *Use online maps, nautical charts, aerial photography, and other resources to preview each channel to be counted. Determine whether channel width will require a count to be taken by boat. Look for potential candidate locations for shore-based counts.*
- *Conduct site visits to confirm potential count locations. Note whether shoreline vantage points are on public or private property and whether special safety procedures will need to be utilized.*

- *Submit proposed count location and methodology for each channel to OMR for review and approval. Revise as necessary and finalize.*

**3) Make logistical arrangements.** Within any quality data collection effort, preparation and planning is critical. This is especially true when collection channel usage data; when logistical arrangement, such as reservation of data collection equipment, transportation for count personnel to and from count locations, locations for breaks, and any necessary boat rentals need to occur. Additionally, ideal count locations may require the cooperation of other agencies or private land owners to access preferred vantage or data collection points.

*Key steps:*

- *Coordinate with property owners if needed to gain access to count site. Note that state and local parks may not open at sunrise and may require special permission to permit early access by the surveyor.*
- *Coordinate with local municipal (police, municipalities, etc.). Provide local officials and police with an NJDOT project authorization letter as well as a 24/7 contact information.*

**4) Select and train personnel to conduct the counts.** A training session for staff who will be conducting the field counts can be used to familiarize staff with count equipment and procedures and to review vessel classification categories. A training session can improve reliability of data collection and reduce discrepancies in vessel classification data, particularly given the subjective nature of the vessel classification scheme. Staff should be trained to classify vessels using a standardized set of categories, and photos of examples of vessels in each category were provided to the counters as part of their field manuals.

*Key steps:*

- *Identify, train and schedule count staff.*
- *Test all count equipment to ensure it is functioning properly and charged.*
- *Hand out all count equipment to count staff prior to the count.*
- *Notify staff prior to count regarding count information, important safety reminders, DOT authorization letter, staff contact list and documenting any issues or unidentifiable vessels.*
- *Send notification to NJDOT headquarters regarding upcoming count.*

**5) Conduct the counts.**

- *Establish uniform guidelines for what constitutes a single count, such as a scenario in which one vessel is towing another vessel. This scenario was encountered during data collection, with each vessel being counted individually.*

**6) Post-process and tabulate results.**

- *Download all count data.*
- *Process all count data*
- *Send a brief memo to NJDOT headquarters regarding any issues encountered during the day of the count.*
- *Develop complete summary of data collected, classified by vessel type.*

Table 6 – Summary of Preferred Data Collection Methods by Channel Attributes

Channel Attributes	Classified Manual Counts	Manual Counts with Still Photography	Manual Counts with Record of Vessel Registration	Manual class count, Digital Photographs, and Record of Vessel Registration	Video Photography (Miovision)
<ul style="list-style-type: none"> <li>• Shoreline accessible</li> <li>• Sight distance 0 – 300 feet</li> <li>• No/low wake zone</li> </ul>	✓	✓	✓	✓	✓
<ul style="list-style-type: none"> <li>• Shoreline accessible</li> <li>• Sight distance 0 – 300 feet</li> <li>• Medium/high wake zone</li> </ul>	✓	Limited (dependent on resolution of digital photos)	Limited (difficult to capture vessel information on fast-moving vessels)	Limited (dependent on resolution of digital photos; difficult to capture vessel information on fast-moving vessels)	✓

<ul style="list-style-type: none"> <li>• Shoreline accessible</li> <li>• Sight distance &gt; 300 feet</li> <li>• Varying wake zones</li> </ul>	✓ with binoculars	Manual class data only	Limited (vessel information)		
<ul style="list-style-type: none"> <li>• Shoreline not accessible</li> <li>• Limited or no sight distance</li> </ul>	✓ from boat				

**TOOLS AND METHODS TO MANAGE CHANNEL COUNT AND CLASSIFICATION DATA**

NJDOT could consider using existing roadway traffic count management systems as a platform for storing and managing channel count data, or OMR could consider developing a new, similar system specifically for channel count data.

The following tools are used by NJDOT to manage roadway traffic count data (source: “New Jersey Traffic Monitoring Program,” prepared by the Traffic & Technology Section of the Bureau of Transportation Data and Safety (BTDS), last updated June 5, 2014):

**Traffic Data System (TRADAS)** is a traffic data analysis system from High Desert Traffic LLC that provides data warehousing toolkit for managing NJDOT’s roadway traffic count data. . TRADAS is used in processing, editing, summarizing, storing and reporting traffic data. The software analyzes and generates monthly and annual statistics of classification and volume data. It is a self-contained package consisting of an Oracle database and a processing application. This application could be the primary source for NJDOT’s waterway count and classification data.

A second database called **TMSCENTRAL** is used as the backbone for the bureau’s Intranet and Internet applications. TMSCENTRAL is an in-house designed program that supports our internet search engine “Data Viewer” and raw data upload. TMSCENTRAL stores directional AADTs, Hourly Peak Volumes (short term counts only), and hourly per lane vehicle classification data from continuous (permanent) stations. TMSCENTRAL contains location details including linear (Standard Road Identifier SRI and Mile Post) and spatial (longitude and latitude) coordinates. In addition, every location is linked with a set of images. This application or a similar application could be used to store count location attributes and photos showing vantage points for waterway counts.

**Relationship Database Management System (RDBMS)** stores information on each count including such attributes as location (milepost and latitude/longitude), type of count, functional class of roadway, latest AADT (by direction if applicable), and date of last count. Based on which County or region will be studied, the BTDS can extract information from the RDBMS and plot the short-term count locations on a map using ArcGIS software. This application could be expanded to store similar information about waterway counts.

As NJDOT updates and upgrades the functionality of, and replaces these three systems with newer technology, the functional requirements of a new system or systems could include the following functional elements:

- A user with limited access rights could input new waterway counts for review prior to acceptance.
- A user with broader rights could view uploaded counts, provide comments after a quality assurance review, and edit counts that are stored in the system.
- NJDOT staff, and potentially others outside NJDOT, could view a history of counts by location. The system could include the capability to query channel count and classification data via a user-friendly interface and/or GIS, similar to existing roadway traffic count viewers at NJDOT and other departments of transportation.

## CONCLUSIONS AND RECOMMENDATIONS

Research and field experience gained from the pilot data collection effort led to the following findings, conclusions, and recommendations.

- **More information is needed regarding variables that could affect accuracy and precision of count methodologies.** The field data collection took place on three days with ideal weather conditions (sunny with few clouds in the sky). Future research may be needed to determine the impacts of clouds, rain, wind, temperature, or other weather variables on the accuracy and precision of each of the four methodologies and how these variables affect the number of vessels in the water on a given day.
- **More data collection is needed** to develop valid statistical models and regression equations that could help NJDOT determine which variables affect count and type of vessels in a channel on a given day. Weather almost certainly impacts the number and type of vessels in a given channel on a given day, but the magnitudes of the impacts of weather conditions and correlations between weather and non-weather variables are unknown. Such non-weather variables could be significant and include channel width and depth, channel accessibility, vertical constraints and the presence of boating schools or events. Logistical needs dictate that vessel counts must be scheduled in advance, but ideal weather conditions cannot be guaranteed. Having a better understanding of the extent to which various weather variables impact vessel use could allow NJDOT to apply correction factors to future vessel counts conducted in less-than-ideal weather conditions. This improved

understanding however, will come as a result of continued data collection in ideal and safety permitting, less-than ideal weather conditions, throughout various days and times of the year.

- **Develop a procedure for collecting counts on a regular schedule.** The procedure should be tailored to the geography surrounding the channel (which will affect how the data are collected), the channel's function in New Jersey's waterway system (a corollary to roadway functional classification that may be related to use and economic value), and relationship to the maintenance dredging program (which may determine the need to do before/after counts).
- **Continue to collect data in a wide range of field conditions** so that, over time, NJDOT will have sufficient data to run regression models to determine (a) which variables affect the accuracy and precision of each count methodology, and to what extent, and (b) which variables affect the use channels by vessel type. Additional data also can help NJDOT determine how often count and classification data need to be collected for each channel or type of channel in order for the samples to provide statistically-valid data. A list of specific variables to test is contained in the Conclusions and Recommendations section.
- **Develop a set of factors to correct for variables that affect vessel counts and classifications** so that count and classification data can be normalized depending on when, where and under what weather conditions the count was conducted. Although the research team encountered uniform ideal weather conditions while surveying, less-than-ideal weather conditions, and other variables likely affect counts and classifications and need to be accounted for. In order to develop these factors, NJDOT will need to conduct additional tests in a wide range of field conditions, on different days of the week and at different points throughout the year.
- **Develop a pre-survey field guide and checklist** to match suitable count methodologies to known field conditions at each channel (including the weather forecasted for the survey day) and inform logistical preparations. For example, given information about physical conditions at each of the 214 State Channels and the weather forecast, NJDOT and its contractors could determine which methodologies would be most appropriate for the location, where there are publicly-accessible locations to station a field surveyor or set up a Miovision camera, and whether more than one surveyor and/or camera would be needed.
- **Implement a Marine Transportation System data collection program** based on approved methodologies, procedures, collection techniques, and a proposed channel collection schedule.
- **Identify what other information is needed to support asset management-related decision making** in addition to channel count and classification data on New Jersey's Marine Transportation System.



Overall, NJDOT should develop an implementation plan that includes conducting vessel counts and classifications at regular intervals. In response to natural disasters such as Superstorm Sandy, and in preparation for future natural disasters that may potentially affect the New Jersey Marine System, the implementation plan would address asset management needs and priorities based on comprehensive and informative channel usage data. This implementation plan could be developed and implemented at relatively low cost statewide. The low cost of implementation reflects the ability to use relatively simple equipment, including binoculars, electronic count boards and cameras, as well as the ability to perform simultaneous collections on particular days and/or time periods of interest. The implementation plan would be developed as a result of continued data collection, using the recommended six step method and suggested collection techniques based on channel attributes.

Count and classification data associated with channel use could also be combined with other existing NJDOT data, including information on the number and types of vessels docked in each watershed, and other multi-modal transportation asset data including critical roadway, rail and utility infrastructure needs. Together, this information could further resiliency efforts to better protect New Jersey's critical infrastructure from future natural disasters, and significantly reduce damage costs. The pilot channel usage data collection methodology that was identified and conducted through this project presents a strong first step towards those efforts.