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FINAL TECHNICAL MEMO

OUTER BANKS GROUP PARKS VISITOR TRAVEL AND USE STUDY

3.30.2018



PREPARED FOR:
OUTER BANKS GROUP PARKS

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1.0 INTRODUCTION

To inform the development of a Visitor Use and Travel Study, the Outer Banks Group (OBG) and the National Park Service (NPS) Social Science Program (SSP) contracted RSG to provide expertise on visitor use measurement and research design. Specific areas of expertise include industry-accepted standards for visitor use estimation, measurement of travel patterns, survey research, sampling approaches to collect representative data, and statistical procedures to analyze these data. This technical memo summarizes work completed for Phase I of the Visitor Use and Travel Study and recommends a visitor use and social science research plan for OBG to address information gaps and research needs related to visitor use and travel in Cape Hatteras National Seashore (CAHA).

OBG comprises three congressionally designated units of the National Park System: CAHA, Fort Raleigh National Historic Site (FORA), and Wright Brothers National Memorial (WRBR). These three park units are collectively managed as a single NPS unit. Despite management as a single administrative unit, these units face unique contexts and challenges due to the varying natural and cultural resources prominent within each unit. With porous park boundaries, miles of beach access points, designations of beaches as either vehicle-free or permitting off-road vehicles (ORV), and seasonal swings in visitation and recreational activities, CAHA was selected as the focus for implementation of Phase I of the Visitor Travel and Use Study, per direction received from OBG management. As such, project scoping conversations held via teleconference and during the onsite scoping trip focused exclusively on exploring approaches for data collection that will yield accurate and defensible characterizations of CAHA's uses and users in future phases of visitor use and social science research.

A primary element of Phase I project development was the identification and refinement of the park's priority research questions for the Visitor Use and Travel Study at CAHA. The identification of priority research questions for CAHA was initiated in August 2015 with a Social Science Needs Assessment conducted by the NPS SSP for OBG. Based on direction from OBG, the list of priority research questions was refined to identify the following four questions as the primary focus for Phases I of the Visitor Use and Travel Study:

1. What percentage of CAHA's total visitation engages in ORV use, travel, or experience?
2. What activities are beach users at ORV and VFA beaches engaging in?
3. Where are beach users at ORV and VFA beaches getting their information from?
4. What are the relative levels of ORV and non-ORV beach use throughout the ORV and VFA beaches in CAHA?

In August 2017, RSG staff traveled to CAHA to meet with OBG staff, learn about current visitor use measurement procedures, become familiar with the park and its existing counting infrastructure, observe visitor use, and discuss current and future data needs to address OBG's priority research questions. RSG's onsite presence was divided into two distinct periods: a two-day onsite scoping trip followed by a nine-day onsite exploratory data collection period.

The two-day onsite scoping trip (August 22–23, 2017) was designed to enable RSG staff to become familiar with the park through in-person discussion with park staff and first-hand observation of the park's landscape, uses, and users. Activities on Day 1 (August 22, 2017) included a classroom-style session with OBG managers and a tour of CAHA led by a group of park staff. During the class-room style session, the park's priority research questions for the Visitor Use and Travel Study in CAHA were discussed and refined. RSG revised

plans for onsite data collection activities based on the feedback and direction received during this session. Specifically, new information on the topics of sampling logistics, beach use and user profiles of interest, and upcoming park projects helped to refine the previously developed onsite data collection plans to more explicitly meet the park's interests and needs. The classroom-style session was followed by an in-person tour of the park with a smaller group of OBG staff. During this tour, park staff provided on-the-ground context for visitor use and travel issues discussed during the classroom-style session. Topics of focus for the staff-led tour included ocean-side beach uses and users, beach access ramps designed for ORVs, the location and accuracy of park-managed visitor use count equipment, and vehicle-free ocean-side beach areas. Activities on Day 2 (August 23, 2017) of the onsite scoping trip included independent travel by RSG staff throughout CAHA to deploy equipment and scope the park for onsite data collection feasibility.

The two-day scoping trip was followed by nine days of exploratory data collection during the period of August 24 – September 3, 2017, during which an RSG data collection technician tested data collection methods and equipment. Detailed descriptions of the data types collected and high-level results are presented in the sections, *Summary of Onsite Data Collection* and *Onsite Data Collection: Frequencies and Lessons Learned*.

RSG has compiled and evaluated information learned from park staff through project scoping calls, a review of previously conducted social science research in CAHA, onsite meetings, and outcomes of the onsite data collection efforts. This information has informed the development of a recommended visitor use and social science research plan presented in the *CAHA Visitor Use and Social Science Research Plan* section of this report, which includes descriptions and rough order of magnitude (ROM) cost estimates for the following five studies:

1. CAHA Parkwide Beach Use Estimation Study.
2. CAHA Parkwide Visitor Survey.
3. CAHA Parkwide Visitor Survey: Public Use Statistics Module.
4. CAHA Beach Users Study: ORV Beaches.
5. CAHA Beach Users Study: VFA Beaches.

The rest of this technical memo reports outcomes of the onsite data collection efforts and presents the recommended visitor use and social science research plan for CAHA.



2.0 SUMMARY OF SUMMER 2017 EXPLORATORY DATA COLLECTION

Data were collected at select locations in CAHA on nine days during the period of August 24 – September 3, 2017. A region-based approach was used to divide the park into four geographically distinct areas for data collection. Regions were created to group visitor use areas within the park by geography, to reflect similarities in visitor use patterns and activities, and for implementation feasibility. The data collection regions, circled in red in Figure 1, are as follows: 1. Bodie Island, 2. Hatteras Island North, 3. Hatteras Island South, and 4. Ocracoke Island. These data collection regions are referenced throughout the rest of this report.

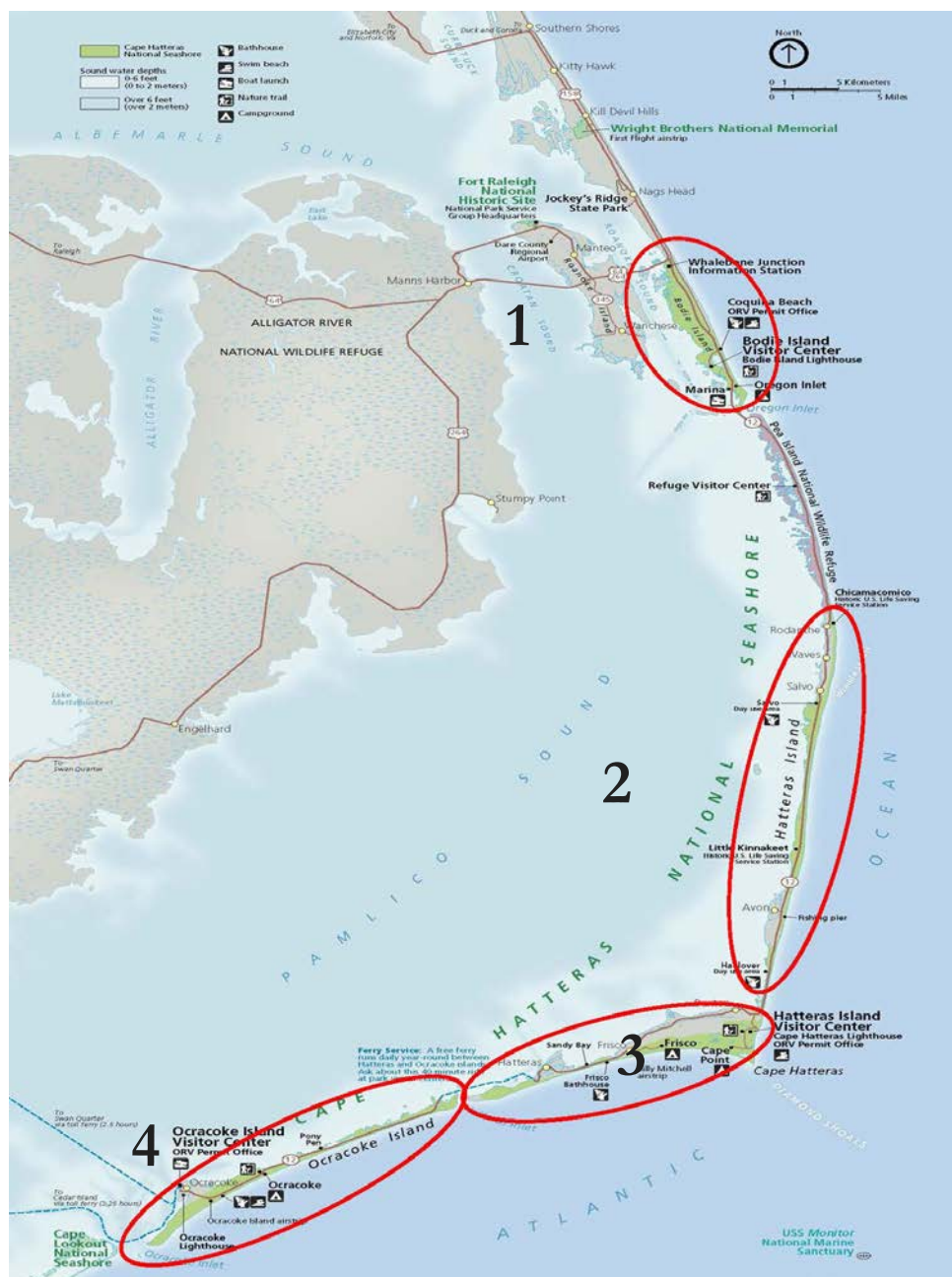


FIGURE 1. CAHA DATA COLLECTION REGIONS

Prior to onsite scoping and data collection at CAHA, a study plan was created to guide exploratory data collection efforts in the park during summer 2017. Study plan development was informed by the scope of work, review of previously conducted visitor use research at CAHA (see Appendix 1 for list of reviewed studies), and project scoping calls with park staff. Additionally, virtual tours of the park via Google Earth led by park staff for RSG staff prior to the onsite visit aided in the development of the 2017 study plan by adding a spatially explicit context to the review of background information and project-related planning and conversation.

Data collection and scoping efforts were designed to be exploratory in nature, with implementation focusing on development of a preliminary understanding of aspects likely to affect the development of a larger, more comprehensive research design, both within regions of the park and at the parkwide scale. These aspects included:

- Visitor behaviors, patterns, and uses throughout CAHA.
- Park infrastructure, with an emphasis on visitor facilities and access points.
- Visitor attitudes and reactions to in-person data collection approaches.
- Feasibility and accuracy of using automated data collection methods.

The nine days of data collection were divided among the four, predefined regions of CAHA (Figure 1). Data collection activities included the following:

- **Visitor Contacts:** Brief, in-person contacts during which visitors were asked a short series of questions designed to test question language and determine the feasibility of in-person visitor contacts for data collection in future phases of work. No more than nine in-person contacts were conducted at each site in accordance with the Office of Management and Budget (OMB) rules. As such, the information collected through these contacts is not generalizable to target visitor populations and was collected primarily with the intent to inform future, larger-scale research efforts at CAHA. In-person visitor contacts were made at the following locations to understand the responses of the range of beach use and user profiles that exist in CAHA:
 - Bodie Island Visitor Center/ORV Permit Office Complex.
 - ORV Beaches accessed via Ramps 2 and 48.
 - VFA Beaches across from Little Kinnakeet Station and near old Ramp 45.
 - VFA Day Use Beach Areas in Frisco and on Ocracoke Island.
 - Avon Pier Village Beach Area.
 - Swan Quarter Ferry.
- **Automated Count Equipment:** Three types of automated count equipment were deployed during the onsite data collection period to record time-stamped count data at access points to beaches. The following automated count equipment were deployed during the study period:
 - *TRAFx Trail Counters:* One TRAFx (brand) passive, infrared trail counter was deployed on the pedestrian boardwalk providing beach access to the Frisco Day Use Beach from the parking lot in the South Hatteras Island data collection region. The counter was temporarily attached to the boardwalk leading to the beach area from the parking lot to test the viability of using trail counters to record volumes of pedestrian-based access to beaches at this location and other similar beach access locations in future visitor use studies.



- *TRAFx Vehicle Counters*: TRAFx passive, magnetic vehicle counters were deployed on the following ORV beach access ramps: Ramp 2, Ramp 25, and Ramp 44. The counters were temporarily buried in the sand alongside the ramps to test the viability of using magnetic vehicle counters to record counts of vehicle traffic on these and other vehicle-based beach access ramps in future visitor use studies.
- *JAMAR Automated Traffic Recorders*: JAMAR (brand) pneumatic tube vehicle counters were deployed to record vehicle counts on roadways on the following sections of road in CAHA:
 - Coquina Beach Parking vehicle entrance (Bodie Island).
 - Lighthouse Road just south of Flowers Ridge Road (Hatteras Island South).
 - Cape Hatteras Lighthouse Day Use Area Parking vehicle entrance (Hatteras Island South).
 - Lighthouse Road north of where the road splits between the Cape Point Campground and the access areas for Ramp 43 and 44 (Hatteras Island South).

These counters were deployed to test the viability of using JAMAR pneumatic tube vehicle counters to record vehicle volumes on paved roads near entrances to parking areas.

- **Observation-Based Counts**: Two types of observation-based counts were conducted during the onsite data collection period: vehicle and pedestrian flow counts and at-one-time observation counts. These data were collected primarily to understand the feasibility of using various count methods to quantify amounts of flows of vehicles and pedestrians in unique locations across CAHA. These data were not collected for the purposes of generating use estimates. Where appropriate, observation-based data were used to determine calibration coefficients for automated count equipment deployed on roadways, ramps, and boardwalks.
 - *Vehicle and Pedestrian Flow Counts*: Observation-based counts of vehicles or pedestrians were recorded in 15-minute increments at beach access locations in CAHA to document use flows at specific locations for specific amount of times. Where automated count equipment was deployed, these data represent actual flows of pedestrians or vehicles at a count location and were used to calculate calibration coefficients for the automated counter data by comparing automated counts with actual (i.e., observed) counts. The calculation of a calibration coefficient provides a measure of the accuracy of the deployed counter. Knowing this information is integral to determining if automated count equipment can be used in CAHA to record counts of vehicles or pedestrians in future studies. Specific areas of interest for calculating calibration coefficients were on ORV access ramps at beaches permitting ORV use and on pedestrian boardwalks where there was the greatest uncertainty about the viability of using automated counting equipment to monitor visitor use.
 - *At-One-Time Observation Counts*: Instantaneous counts of people-at-one-time and vehicles-at-one-time were conducted on popular sections of beach in CAHA. These counts were conducted to gather information on the feasibility and accuracy of conducting simultaneous people and vehicle at-one-time counts in popular ORV beach areas in CAHA, such as in and around the Cape Point Area. Strategies were identified to tailor existing methods for at-one-time counts to overcome the unique logistical challenges of counting on beaches for future potential counting efforts.

Parking lot turnover counts were also conducted to measure the number of vehicles-at-one-time in the Coquina Beach parking lot. To collect this data, a count of parking lot arrivals was conducted, and license plate numbers were recorded. At set time intervals, the study administrator made a pass through the parking lot to identify new license plates and record remaining license plates. This type of data collection procedure enables the determination of length of stay of vehicles in the parking lot, providing a measure for how long people stay at a given beach. The Coquina Beach parking area was used as a test location for this type of data collection, which could be applied to other beach parking areas in potential future studies.

In summary, three primary methods were used to collect data during the nine-day exploratory onsite data collection period: visitor contacts, automated count equipment, and observation-based counts. These data were collected with the primary purpose of understanding the feasibility of their use in future, representative data collection efforts at the park. These data were not collected for the purposes of generalization or to understand representative patterns and trends in uses and users. Therefore, data summaries in the next section of this report present summary information and highlight lessons learned.



3.0 ONSITE EXPLORATORY DATA COLLECTION: SUMMARIES AND LESSONS LEARNED

Results from the exploratory onsite data collection period are reported by data collection method. Within each data collection method, summaries of information and lessons learned are presented; due to the exploratory nature of the data collection and OMB-related limits on the number of groups contacted, sample sizes and descriptive statistics are not reported.

3.1 | VISITOR CONTACTS

BEACH USERS: ORV PERMITTED BEACHES

Project scoping and development identified beach users with ORVs to be a primary user group of interest to park managers, with the acknowledgement that the label “ORV users” oversimplifies the full characterization of visitors who use ORVs on the beaches at CAHA. Thus, exploring methods for generating a representative sample of beach users with an ORV and engaging in contacts with these beach users was an activity of focus during the onsite data collection period. RSG’s onsite data collection technician approached beach users on ORV beaches in-person, speaking with them using a short, interview-style script, asking the following questions about the visitors’ trips to the Outer Banks and CAHA:

1. Are you a local resident of the Outer Banks or are you traveling to the beach from out of town?
2. Are you visiting Cape Hatteras National Seashore just for the day or are you here for a multiday trip?
If the visitor was on a multiday trip, the following additional questions were asked about their trip:
 - a. How many days is your trip, in total, to Cape Hatteras National Seashore?
 - b. On how many of those days do you plan to drive your ORV on the beach?
 - c. Which ramps do you plan to use?
 - d. Where are you staying on your trip?

The questions were designed to gather exploratory information from beach users generally, with additional questions designed specifically for those users that had an ORV on the ORV permitted beach. Observed group size and contact gender were also recorded. If the visitor refused to participate in the contact, the refusal reason was recorded if provided.

Two types of locations were scoped for sampling beach users that planned to use an ORV on an ORV permitted beach: park offices where ORV permits can be purchased and park beaches where ORV use is permitted. Ultimately, onsite scoping suggests that contacting visitors directly at ORV beaches is the approach that maximizes sampling efficiency while reducing visitor burden. Therefore, this approach is incorporated into the recommended study designed to collect information from visitors using beaches where ORV use is permitted in CAHA.

Contacting visitors using ORV beaches maximizes sampling efficiency by increasing the likelihood that contacts made are with visitors that are using, or plan to use, an ORV while visiting the park. Visitor contacts were conducted at both permit offices and on ORV beaches, with the permit office contacts yielding a significantly higher number of ineligible contacts (i.e., contacts that were not visitors planning to use an ORV while in the park). In the park, offices where ORV permits are sold and distributed are collocated with other popular visitor facilities and attractions such as historic lighthouses, gift shops, and restrooms. The presence of these other facilities in the area makes it difficult to identify visitors purchasing ORV permits from among

those in the area to use other facilities. Moreover, the complex of visitor facilities creates challenges for implementing systematic random sampling techniques necessary for generating a representative sample. In contrast, sampling visitors using ORV beaches increases the likelihood that visitors contacted qualify to participate in a study seeking to collect information from visitors using ORVs in the park. Sampling on beaches where ORV use is permitted also reduces the complexity associated with implementing a systematic random sampling approach.

This approach also minimizes burden to visitors. Through approaching visitors once they have already reached a destination on their trip (the beach), this approach minimizes research-related delays in visitor travel that may be caused by sampling at other locations, such as park offices where ORV permits are sold. Moreover, onsite data collection on beaches where ORV use is permitted suggests that visitors at these locations are generally easy going and are willing to participate in research-related visitor contacts. In addition, it would be possible to conduct unobtrusive observational studies of ORV users on beaches, to supplement or substitute for asking visitors questions via a survey. That said, sampling at the ORV permit offices would provide the opportunity to concurrently collect other information about the purposes for which visitors come to the Visitor Centers and percentages of visitors at the Visitor Centers who are there to obtain an ORV permit versus being there for other reasons. Moreover, sampling at ORV permit offices provides measures of what visitors plan to do, rather than what they did do; the preferred measure depends on the purposes of the collection.

Table 1 presents a descriptive summary of the information collected from visitors using ORV beaches during the exploratory onsite period. It should be noted that the information presented below is not representative of the population of visitors using beaches where ORV use is permitted, but it is indicative of the type of information that can be collected from a representative sample of beach users in future studies.

TABLE 1. VISITOR CONTACTS: BEACH USERS, ORV PERMITTED BEACHES

Beach Users, ORV Permitted Beaches: Summary of Visitor Contacts	
Group Size	Group sizes ranged from 1 to 14 people. Groups were equally split between having no children in their group and having one or more children in their group.
Local/Nonlocal	Most contacted groups were nonlocal, with some of the contacted groups being local residents of the Outer Banks.
Day/Multiday	Contacted groups were more likely to be on multiday trips to CAHA, than on day trip.
Nonlocal, Multiday Visitors	
ORV Use	Nonlocals on a multiday trip planned to drive their ORVs on the beach on multiple days, ranging from between 2 and 14 days. For groups on multiday trips, most groups planned to use their ORV for 7 days. When asked what ramps they planned to use to access the beach with their ORV, all groups provided at least some information on where they planned to access the beach with their ORV. However, some groups were unable to provide specific



Beach Users, ORV Permitted Beaches: Summary of Visitor Contacts

	ramp numbers and provided general areas of CAHA where the planned to drive on to the beach instead (i.e., “Cape Point Area,” or “down in Hatteras”).
Location of Stay	Nonlocals: Avon, Buxton, Campground (Hatteras Sands, Frisco, Frisco Woods, Cape Woods), Hatteras, Kill Devil Hills, Nags Head, Ocracoke, Salvo, Virginia Beach.

BEACH USERS: VEHICLE-FREE BEACHES

Project scoping and development identified visitors using VFA beaches as a visitor group of interest to park managers. While visitor contacts are described in this report as occurring on beaches where ORV use is permitted and beaches where ORV use is not permitted, we acknowledge that this distinction is an oversimplification of the visitor experience, and that the target of these contacts was to describe the range of visitor types in diverse locations, included beaches in CAHA.

Contacts with visitors using VFA beaches were conducted in the same style and format as contacts with visitors on beaches where ORV use is permitted. The following questions about the visitors’ trips to the Outer Banks and CAHA were asked during the contact:

1. Are you a local resident of the Outer Banks or are you traveling to the beach from out of town?
2. Are you visiting Cape Hatteras National Seashore just for the day or are you here for a multiday trip?
If the visitor was on a multiday trip, the following additional questions were asked about their trip:
 - a. How many days is your trip, in total, to Cape Hatteras National Seashore?
 - b. Did you know that this beach is a vehicle-free beach area?
 - c. Did you come to this beach because it was a vehicle-free beach or for another reason? If other reason, what is the other reason?
 - d. Do you have an ORV permit?
 - e. Where are you staying on your trip?

The questions were designed to gather exploratory information from beach users generally. Observed group size and contact gender were also recorded. If the visitor refused to participate in the contact, the refusal reason was recorded if provided.

Onsite scoping and data collection suggests that contacting visitors using VFA beaches on the beach itself is a viable option for contacting a sample of visitors in these park areas. Onsite scoping found beach users on VFA beaches to be willing to participate in the onsite visitor contacts. In fact, no refusals were experienced from visitors at these locations during the onsite data collection period.

It should be noted that during the onsite sampling period, use at the VFA beaches varied widely, impacting the ability to make contacts at VFA beaches. For example, the VFA beach areas across from Little Kinnakeet Life Saving Station and in front of the old Ramp 45 in South Hatteras had few users on the days on which they were sampled and therefore, few opportunities to make contacts at these locations. Conversely at VFA beach areas marked as designated “day use areas” on park maps, many opportunities for contacts existed due to the continuous use of these areas by park visitors. Variation in visitor volumes across VFA beaches should be considered in the design of future sampling schedules focused on collecting information from park visitors

using VFA beaches. More time may be needed to contact the target number of respondents among visitors using VFA beaches at some lower use VFA beaches in the park. These scoping results further suggest that it may not be appropriate to treat all VFA beaches as a single sampling unit, but instead, it may be necessary to segment VFA beaches to distinguish, for example, between day use areas/lifeguarded beaches and other VFA beaches.

Table 2 presents a descriptive summary of the information collected from visitors using VFA beaches. It should be noted that the information presented below is not representative of visitors at these locations, but it is indicative of the type of information that can be collected from a representative sample of beach users in future studies.

TABLE 2. VISITOR CONTACTS: BEACH USERS, VFA BEACHES

Beach Users, Vehicle-Free Beaches: Summary of Visitor Contacts	
Group Size	Group sizes ranged from 2 to 12 people, with the average group size being approximately 4 people per group. Groups were about equally split between having no children in their group and having one or more children in their group.
Local/Nonlocal	All groups were nonlocal.
Day/Multiday	All groups were on multiday trips.
Nonlocal, Multiday Visitors	
VFA Use	Trip lengths ranged from 2 to 14 days in length. Most trips were about a week long. About half of the contacted visitors knew the beach on which they were contacted was a VFA beach; however, only one group chose the beach on which they were contacted because it was a VFA beach. Other reasons for selecting the beach among contacted groups include: convenience (near rental); presence of facilities such as bathrooms, life guards, and parking; tradition (i.e., the contact group always comes to this spot); another area that they usually use was closed due to wildlife; and for quiet. Few groups intercepted on VFA beaches also had an ORV permit. One group mentioned planning to purchase an ORV permit during their trip to CAHA.
Location of Stay	Avon, Buxton, Campgrounds (Buxton, Frisco, Hatteras, Ocracoke), Frisco, Hatteras, Ocracoke, Salvo.



BEACH USERS: VILLAGE BEACHES

Conversation during the onsite meetings and tour of the park with CAHA staff identified visitors using CAHA beach areas in front of Outer Banks Villages as a visitor profile of interest for potential future survey-based research. Park staff identified the unique experience of beach users using village beaches being able to “walk out” their front doors onto the beach. Additionally, public beach access points exit in the villages providing easy access for this beach goers that do not have “front door” beach access. These unique experiences may cause village visitors to experience CAHA beaches differently than other beach users in the park. Given the interest in this beach user experience, village beach users near the Avon Village Pier were contacted to explore methods for generating a representative sample of visitors using village-front beach areas and engaging in contacts with these users. Village beach users were contacted in a manner consistent with other beach contacts conducted as part of Phase I. The following questions about the visitors’ trips to the Outer Banks and CAHA were asked during the contact:

1. Are you a local resident of the Outer Banks or are you traveling to the beach from out of town?
2. Are you visiting Cape Hatteras National Seashore just for the day or are you here for a multiday trip?
If the visitor was on a multiday trip, the following additional questions were asked about their trip:
 - a. How many days is your trip, in total, to Cape Hatteras National Seashore?
 - b. Did you know that this beach is a vehicle-free beach area?
 - c. Which best explains why you are using this beach? a) it is near my rental home, b) because it is a vehicle-free beach, or c) for another reason.
 - d. Do you have an ORV permit?
 - e. Where are you staying on your trip?

Observed group size and contact gender were also recorded. If the visitor refused to participate in the contact, the refusal reason was recorded if provided.

Onsite scoping and data collection suggests that contacting visitors on village beaches is a viable option for contacting a random sample of village renters/residents. Users contacted near the Avon Pier were willing to participate in the onsite visitor contacts. In fact, no refusals were experienced during the onsite data collection period.

It should be noted that the beach near the Avon Village Pier was selected as the sample location for Phase I, in part, because a public access route is available near the pier allowing RSG’s data collection technician to walk on to the beach without trespassing on private property. It is possible that beach users in this area were more amenable to being contacted due to the presence of development or other public amenities around this beach. For future implementation, care should be taken if sampling were to occur in front of rental homes or near private property. Specific points of access for village beach sampling would need to be selected in consultation with CAHA managers to ensure that research-based contacts made on CAHA beaches near the villages are well-received and supported by local residents or organizations in the village communities.

Table 3 presents a descriptive summary of the information collected from visitors on the beach in front of Avon Village. It should be noted that the information presented below is not representative of the population of village beach users, but is indicative of the type of information that can be collected from a representative sample of visitors in this area in future studies.

TABLE 3. VISITOR CONTACTS: VILLAGE BEACH CONTACTS

Beach Users, Village Beaches: Summary of Visitor Contacts	
Group Size	Group sizes ranged from 1 to 10 people. Fewer of the contacted groups had children in their group than no children in their group.
Local/Nonlocal	All groups were nonlocal.
Day/Multiday	All groups were on multiday trips.
Nonlocal, Multiday Visitors	
VFA Use	Five groups knew the beach near Avon Pier was a VFA beach. Only one of those groups mentioned that they chose the beach because it was a VFA. Reasons for selecting the beach among contacted groups include: convenience (near rental), tradition (i.e., the contact group always comes to this spot), for quiet, and due to the presence of nearby attractions. One of the contacted groups also had an ORV permit.
Location of Stay	All groups were staying in Avon Village.

OCRACOKE FERRY CONTACTS

Project scoping and development identified research priorities that would require future studies to obtain a representative sample of all visitors in CAHA (e.g., parkwide visitor survey). Conversations with park staff and onsite scoping revealed that CAHA has two primary access points; virtually all visitors enter CAHA at either its northern-most boundary by vehicle at Whalebone Junction (the intersection of NC HWY 12 and US-64) or at its southern-most boundary by ferry from either Swan Quarter or Cedar Island to Ocracoke Island. Correspondingly, the most direct, comprehensive, and cost-efficient way to obtain a parkwide sample of all CAHA visitors would be via intercepts at Whalebone Junction and on the ferries (Figure 2).

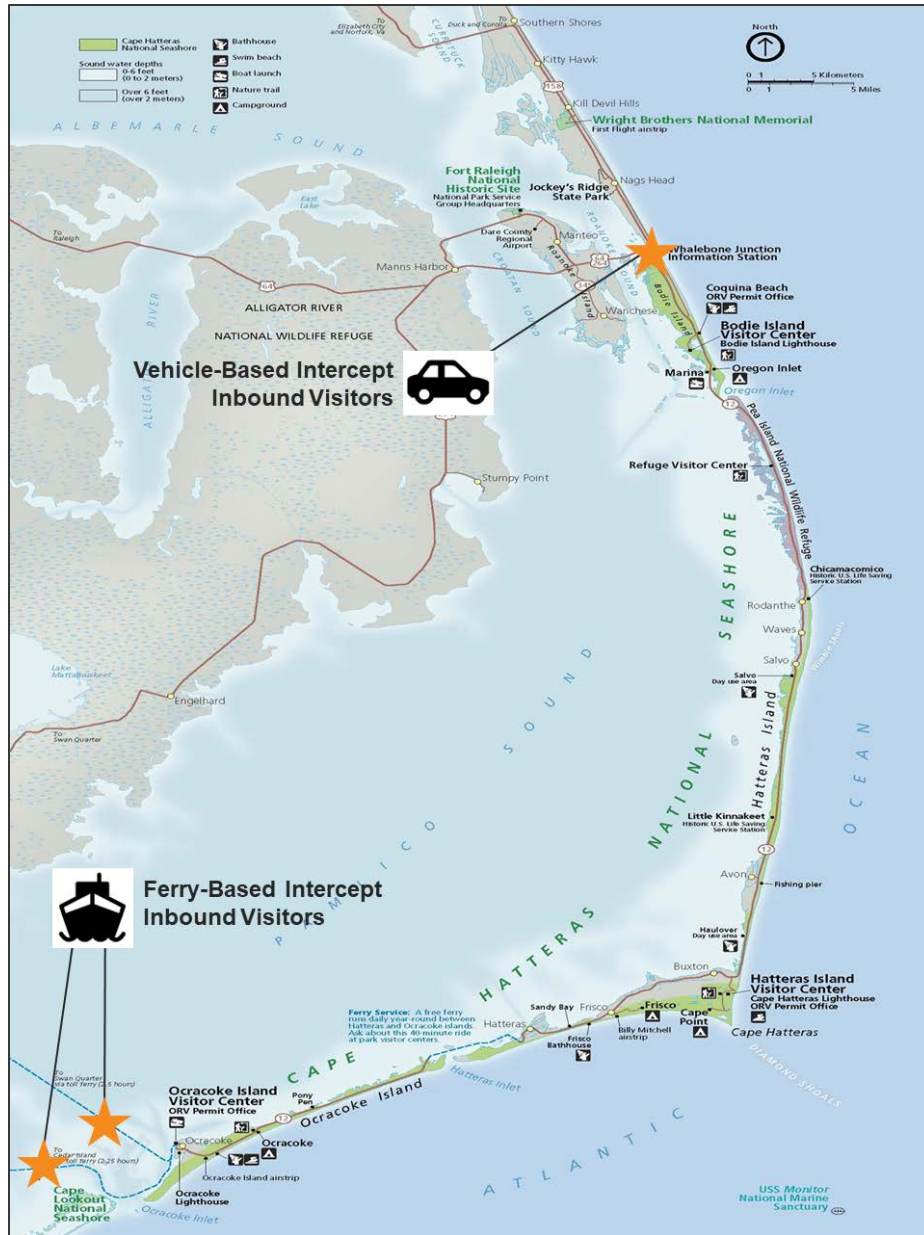


FIGURE 2. POTENTIAL INTERCEPT LOCATIONS FOR PARKWIDE SAMPLING OF ALL CAHA VISITORS

Preliminary site scoping was conducted at Whalebone Junction to observe traffic flow, potential intercept and pullout locations, and potential challenges to intercepting visitors there (Figure 3). Initial scoping suggests that a roadway intercept at Whalebone Junction may be feasible, but merits further scoping and testing to address questions about safety and potential impacts to the local community. For these reasons, in-field testing of conducting a vehicle-based intercept at Whalebone Junction was not conducted during the 2017 onsite data collection period.



FIGURE 3. WHALEBONE JUNCTION NORTHBOUND (LEFT) AND SOUTHBOUND (RIGHT) VIEWS

Testing of the ferry-based intercept was conducted during summer 2017, after receiving approval from the park and from the North Carolina Department of Transportation. An onsite ferry-based intercept was conducted on the Swan Quarter Ferry to test the viability of contacting inbound visitors to CAHA on the ferry prior to their arrival on Ocracoke Island. Ferry riders were contacted in a manner consistent with other visitor contacts conducted as part of Phase I. The following questions about the visitors' trips to the Outer Banks and CAHA were asked during the contact:

1. Are you a local resident of the Outer Banks or are you traveling to the beach from out of town?
2. Are you visiting Cape Hatteras National Seashore for recreation on this trip to the Outer Banks?
3. (*If the visitor was not on a recreation trip to CAHA*) What is your primary reason for your trip to the Outer Banks today? For recreation outside of the seashore, to commute to or from work, home, or another location, or for another reason?

If the visitor was on a recreation trip to CAHA, the following additional questions were asked about their trip:

- a. How many days is this trip to the Outer Banks do you plan to visit Cape Hatteras National Seashore?
- b. Do you plan to drive an ORV on the beach when you visit Cape Hatteras National Seashore?
- c. (If yes) Do you already have an ORV permit or do you plan to purchase one during your trip to Cape Hatteras National Seashore?
- d. Do you plan to be on Ocracoke Island the whole time during this trip to the Outer Banks, or do you plan to visit other areas of the Outer Banks as well?

Observed group size and contact gender were also recorded. If the visitor refused to participate in the contact, the refusal reason was recorded if provided.

Onsite scoping suggests that in-person intercepts of ferry passengers are feasible on both the Swan Quarter and Cedar Island ferry routes (Figure 4). Each ferry ride is at least two hours, making ferry passengers a “captive audience” for participation in a survey-based contact. During onsite data collection, our survey administrator found most contacted individuals to be receptive to answering survey questions they were asked.

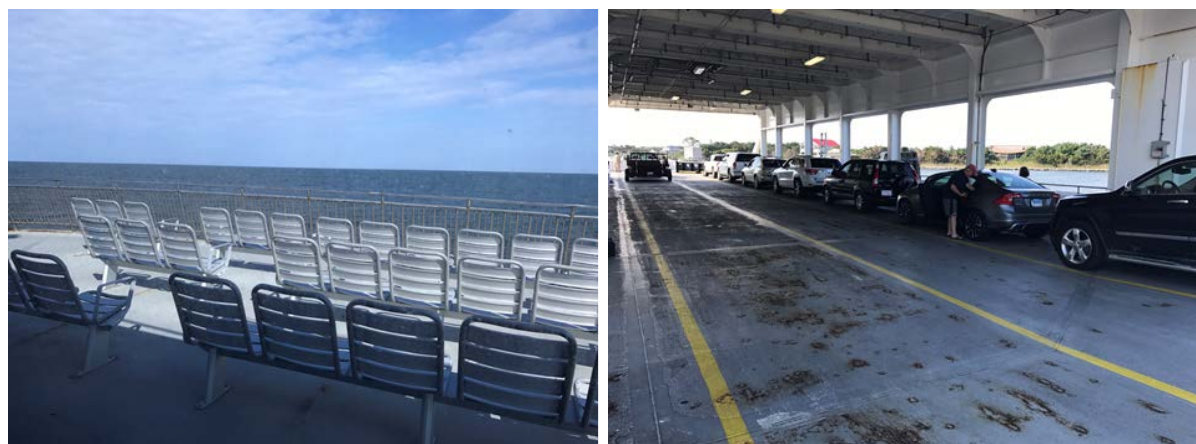


FIGURE 4. SWAN QUARTER FERRY PASSENGER LOUNGE (LEFT) AND CAR PARKING (RIGHT)

Table 4 presents a descriptive summary of the information collected from ferry contacts. It should be noted that the information presented below is not representative of the population of ferry users, but is indicative of the type of information that can be collected from a representative sample of users in future studies.

TABLE 4. VISITOR CONTACTS: OCRACOCKE TO SWAN QUARTER FERRY CONTACTS

Ocracoke to Swan Quarter Ferry: Summary of Visitor Contacts	
Group Size	Group sizes ranged from 1 to 4 people. No groups had children with them.
Local/Nonlocal	All contacts were intercepted during the ferry ride. About half were made during the ferry ride from Ocracoke to Swan Quarter, and the other half were made during the ferry ride from Swan Quarter to Ocracoke. Half of the groups considered themselves to be local to the Outer Banks, while the remaining groups considered themselves to be nonlocal.
Local Ferry Riders	
Trip Purpose	No local groups were visiting CAHA for recreation on their trip to the Outer Banks. Three of the local groups were traveling on the ferry for commuting purposes. One group was traveling to visit family.
ORV Use	Two of the local groups planned to drive an ORV on the beach while they were in CAHA. Both of these groups had already purchased ORV permits at the time we contacted them.

Nonlocal Ferry Riders

Trip Purpose	All nonlocal groups were visiting CAHA for recreation on this trip to the Outer Banks. Three of the nonlocal groups planned to drive an ORV on the beach while they were in CAHA. None of these groups had purchased their ORV permit at the time we contacted them.
ORV Use	All nonlocal groups planned to be on Ocracoke Island for the duration of their visit to CAHA and did not have plans to travel to other parts of the park.

3.2 | AUTOMATED COUNT EQUIPMENT

TRAFx TRAIL COUNTERS

A TRAFx trail counter was deployed at the Frisco Day Use Beach on the pedestrian boardwalk providing access to and from the parking area for the beach. The counter was installed to test the feasibility of using automated count equipment to record pedestrian flows on boardwalk beach access points throughout CAHA. The boardwalk at the Frisco Day Use Beach was selected as a test location for deployment of automated pedestrian count equipment because input from park staff and onsite scoping suggested that the area would have a steady flow of visitors using the boardwalk to access the beach during the data collection period. The steady flow of visitors would provide the circumstances for RSG staff to test the accuracy of trail counter data collected at the Frisco Day Use Beach and other similar sites throughout CAHA.

The TRAFx trail counter was deployed at approximately 10:00am on Friday, September 1, 2017, and was removed at approximately 11:00am on Monday, September 3, 2017. The counter was configured to record data continuously during deployment, recording a count with a time-stamp each time a pedestrian passed the counter in either direction.

Observation-based calibration counts were conducted during a sample of hours in the vicinity of the trail counter to determine the accuracy of the deployed trail counter. The observation-based calibration counts were recorded for two hours in 15-minute bins, generating eight calibration data points for use in calculating a calibration coefficient or correction factor for the trail counter data.



Figure 5 displays a line fit plot displaying the relationship of the count data recorded by the TRAFx counter (x axis) and the observation data recorded by RSG's onsite data technician (y axis) produced by performing a regression analysis on the two variables. The regression estimates for the calibration coefficient ($\beta = 1.345$) and for the measure of how closely the data fit the regression line (Adjusted $R^2 = 0.838$) suggest a strong relationship between the recorded count and observation data. This relationship indicates that deployment of an automated trail counter would be a viable method for collecting data on pedestrian flows at this and other similar boardwalk access points to CAHA beaches.

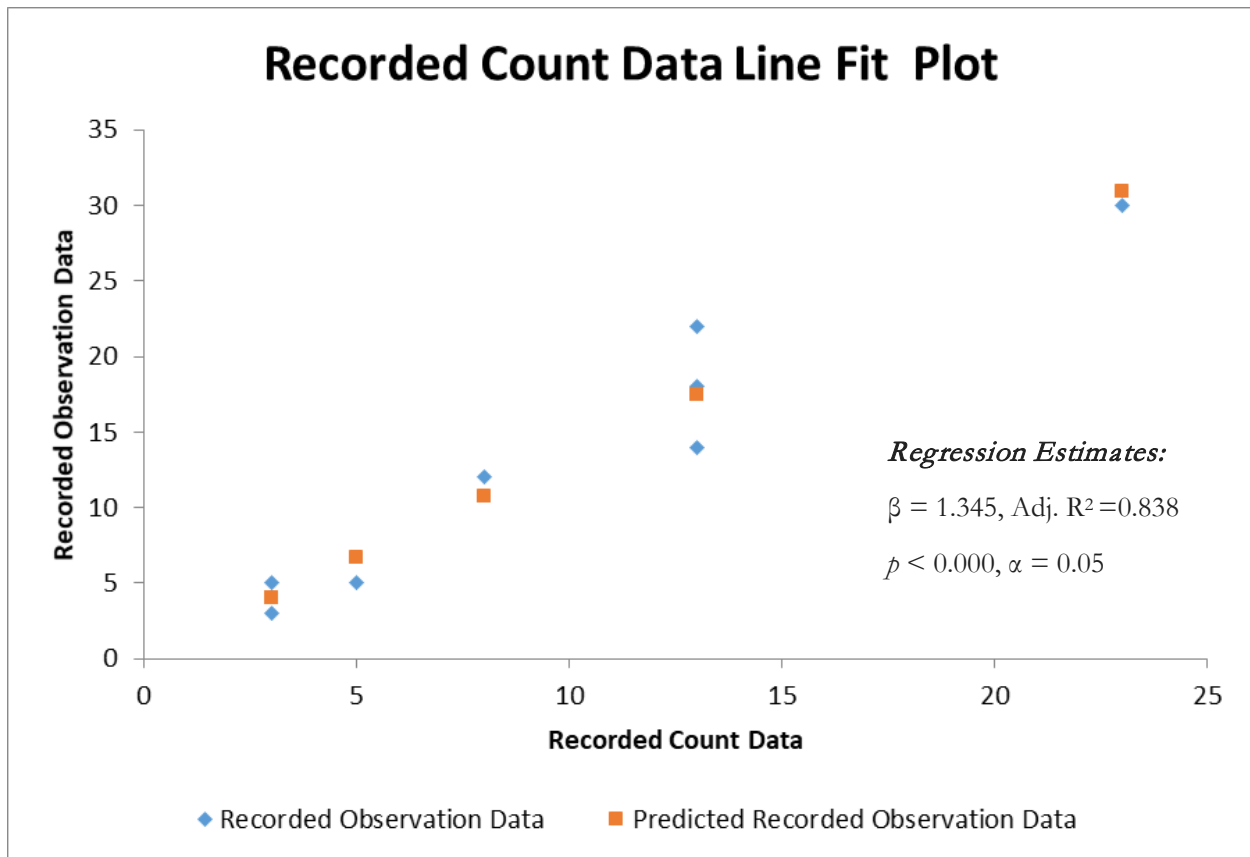


FIGURE 5. FRISCO DAY USE CALIBRATION ANALYSIS LINE FIT PLOT

Figure 6 shows the deployment set up used to test the TRAFx trail counter equipment at the Frisco Day Use Area. The TRAFx unit pictured was deployed for 2 days. A Pelican case was used to protect the unit from the environment, prevent petty theft of the unit, and temporarily secure the unit to the boardwalk post. A system of galvanized cables and webbing was used to secure the Pelican case to the boardwalk post.

If TRAFx trail counters are deployed in future studies, care should be taken to make sure that the trail counters are protected from the wind, rain, and sand to which the equipment would inevitably be exposed. For longer-term deployment, it is recommended that the trail counter units be deployed inside Pelican cases that have customized holes drilled to fit the exact diameter of the counter's scope. An air-tight seal is recommended between the scope and Pelican case to prevent damage-causing moisture from entering the protective Pelican case and damaging the counter. TRAFx trail counters are extremely sensitive to moisture, so care should be taken to reduce the likelihood of moisture exposure in the beach environment.



FIGURE 6. TRAFX TRAIL COUNTER SET UP AT FRISCO DAY USE BEACH, 2017



TRAFX VEHICLE COUNTERS

TRAFx magnetic vehicle counters were deployed at ORV beach access ramps during the onsite data collection period to test the feasibility and reliability of using magnetic vehicle counters to record counts of ORVs entering and exiting beaches at CAHA. Magnetic vehicle counters were deployed on three ramps during the study period: Ramp 2, Ramp 25, and Ramp 44. These ramps were selected to stratify equipment testing across the sampling regions and because discussion with park staff identified them to be active ramps during the onsite data collection period. Observation-based calibration counts were conducted during a sample of hours in the vicinity of each counter to determine the accuracy of the deployed trail counter.

The duration of deployment and hours of calibration data collected varied with each deployment due to equipment limits and onsite sampling logistics. Table 5 reports the details of each installation, including the duration of deployment, amount of calibration data collected, and regression estimates from the calibration analysis for each of the three counters.

TABLE 5. TRAFX VEHICLE COUNTER DEPLOYMENTS: DURATION AND CALIBRATION RESULTS

Location	Ramp 2	Ramp 25	Ramp 44
Deployment	Start: 8/23/17, 10:30am	Start: 8/27/17, 10:00am	Start: 9/1/17, 11:00am
Duration	End: 8/27/17, 5:30pm	End: 8/28/17, 9:00am	End: 9/3/17, 1:30pm
Number of Calibration Hours	2 hours	5 hours	8 hours
Number of Calibration Data Points	8 data points	14 data points	31 data points
Regression Coefficient (β)	0.701	0.686	0.876
Goodness of Fit (Adjusted R²)	0.911	0.841	0.954
<i>p</i>-value	< 0.001	< 0.001	< 0.001

The regression results reported in Table 5 suggest that using magnetic vehicle counters to record vehicle count data on beach access ramps would be a viable option for collecting vehicle volume data in future studies. The strongest relationship between observation-based calibration data and recorded counter data exists for the counter deployment at Ramp 44. This is to be expected as this location not only had the largest amount of calibration data collected for estimating the relationship between observed and recorded counts, but this location also benefitted from being the last location to be installed during the study period. RSG staff incorporated experiences learned through deployment of magnetic vehicle counters on Ramps 2 and 25 into the deployment of the Ramp 44 counter. The calibration results for the Ramp 44 counter present the best case for deployment of a magnetic vehicle counter to record vehicles on ramps in CAHA. Figure 7 displays the line fit plot displaying the relationship of the count data recorded by the TRAFx counter (x axis) and the observation data recorded by RSG's onsite data technician (y axis) produced by performing a regression analysis on the two variables for the Ramp 44 counter.

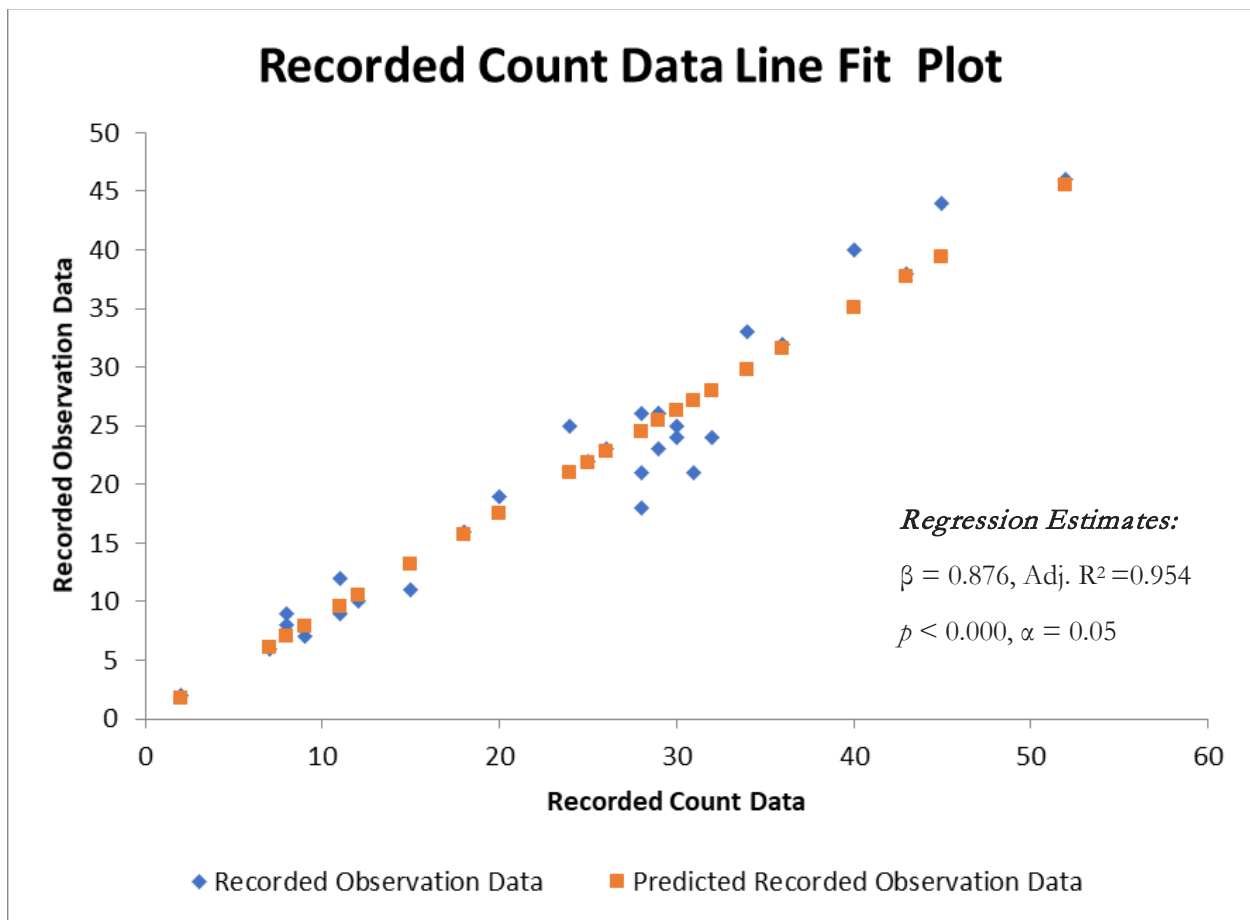


FIGURE 7. RAMP 44 CALIBRATION ANALYSIS LINE FIT PLOT



Figure 8 provides an example of the magnetic vehicle counter deployment set up. Each of the TRAFx magnetic vehicle counters was buried six to twelve inches in the sand on the side of the ramp that inbound vehicles (headed to the beach) tended to use. Positioning of the buried counter followed guidelines outlined in the TRAFx magnetic count equipment installation manual. The buried units were enclosed in a plastic Ziploc bag to keep out the sand and to protect the count equipment from moisture. The bagged counters were locked to nearby brush or marked with flagging to indicate their buried location.



Location of buried
magnetic vehicle
counter

FIGURE 8. RAMP 44 MAGNETIC VEHICLE COUNTER DEPLOYMENT SET UP

If TRAFx magnetic vehicle counters are deployed in future studies, care should be taken to make sure that the counters are securely installed such that movement of the counter during the data recording period is minimized. During the onsite data collection period, RSG staff found the counters to be sensitive to even the slightest movements, recording erroneous count data with slight movements of the counter; once the counters were situated in the ground, they stabilized. Recommended approaches include installing temporary above ground, water proof boxes for count equipment or burying the counter deep enough into the soil that natural erosion in the dune area would not affect the positioning or installation of the count equipment.

JAMAR AUTOMATED TRAFFIC RECORDERS

JAMAR pneumatic tube vehicle counters were deployed during summer 2017 to record vehicle counts on roadways and at entry points to beach parking areas to test the feasibility and reliability of using pneumatic tube counter to record counts of vehicles entering and exiting beach parking areas in CAHA. Pneumatic tube counters were deployed in the following locations during the onsite data collection period (Table 6):

- *Entrance to Coquina Beach parking area, Bodie Island:* A pneumatic tube counter was deployed in the same location as the existing park-managed vehicle counter. The two counters were collocated to generate a preliminary understanding of the accuracy of the park-managed counter relative to the deployed RSG count equipment. Coquina Beach acts as the primary access point for ocean-side beach users in the Bodie Island region of the park; therefore, collecting accurate counts of inbound and outbound users at this location will be integral to future studies seeking to understand visitor flows and travel throughout the park.
- *Hatteras Island South Day Use Locations:* Three pneumatic tube traffic counters were deployed to cordon the main vehicular entrances beach parking areas for non-ORV beach users on the southern end of Hatteras Island. Counters were placed in the following locations (Figure 9):
 - Lighthouse Road south of Flowers Ridge Road (Figure 9, X1).
 - Cape Hatteras Lighthouse Beach Day Use Area Parking vehicle entrance (Figure 9, X2).
 - Lighthouse Road north of where the road splits between the Cape Point Campground and the access areas for Ramp 43 and 44 (Figure 9, X3).

TABLE 6. JAMAR VEHICLE COUNTER LOCATIONS: DURATION AND CALIBRATION RESULTS

Location		Coquina Beach Parking	Flowers Ridge Road (X ₁)	Hatteras Island Day Use (X ₂)	Campground Access Road (X ₃)
Deployment	Start	8/23/17, 10:00am	8/28/17, 6:00pm	8/30/17, 12:00pm	8/28/2017, 4:00pm
Duration	End	8/28/17, 8:00am	9/3/17, 2:00pm	9/3/17, 1:00pm	9/3/17, 1:00pm

The duration of deployment and hours of calibration data collected varied with each installation due to weather and availability of equipment. Specifically, deployment of the JAMAR counters was delayed due to intense rain experienced due to a tropical storm off the coast of Cape Hatteras during the onsite data collection period. Table 6 reports the details of each installation, including the duration of deployment, amount of calibration data collected, and regression estimates from the calibration analysis for each of the three counters.

Coquina Beach Counter

Calibration data were collected for the JAMAR counter deployed at the entrance to the Coquina Beach parking area. These data were collected due to concerns about the accuracy of both the JAMAR and NPS-managed counters arising from the short entry driveway into the Coquina Beach parking area. Best practices for automated traffic recorders recommend placing counters along a straight section of road on which vehicles will be traveling at a consistent speed. The short length of the entry road into Coquina Beach does not meet these recommended standards for installation; therefore, calibration data were collected to explore the accuracy of deployed equipment.

Calibration analysis results suggest that the JAMAR counter was systematically overcounting entering vehicles. The calibration coefficient ($\beta = 0.656$) was applied to the raw JAMAR counter data to generate a calibrated inbound vehicle count for the Coquina Beach parking area. This calibrated counter data was then compared to the NPS-managed counter data. The data were regressed to calculate a relationship between the NPS-managed and deployed JAMAR data. The resulting relationship suggests that the NPS counter is slightly overcounting inbound vehicles ($\beta = 1.17$; Figure 10). Overall, the calibration analysis of both the JAMAR and NPS-managed counter suggests that regardless of the counter technology deployed, observation-based count data will need to be collected to calibrate recorded vehicle counts at the Coquina Beach parking area due to limitations in the site's geography for counter installation.

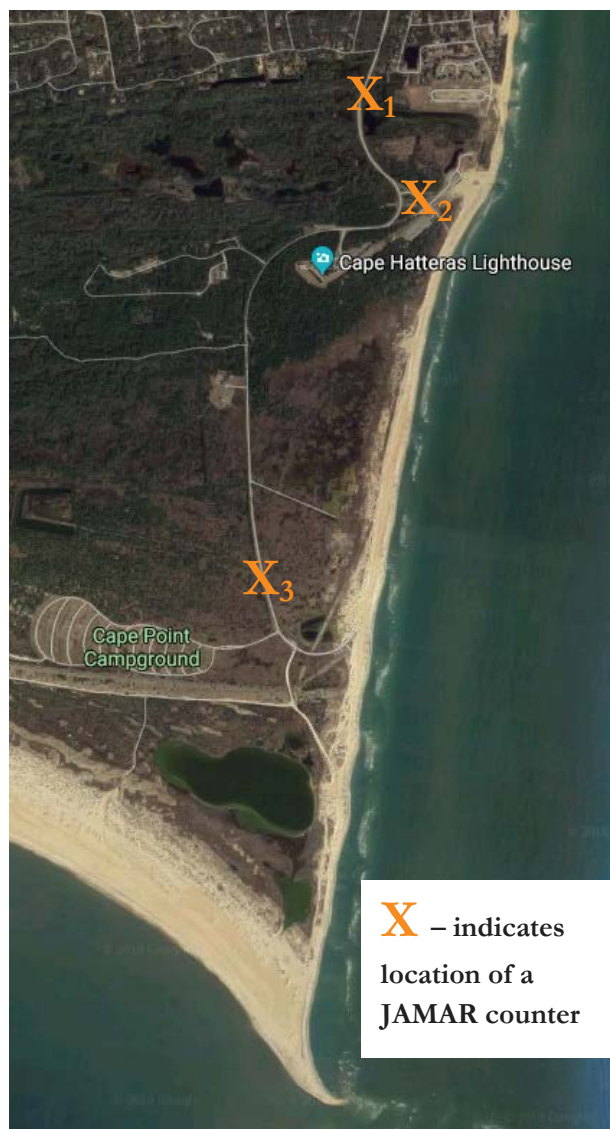


FIGURE 9. LOCATION OF JAMAR COUNTERS, HATTERAS ISLAND SOUTH

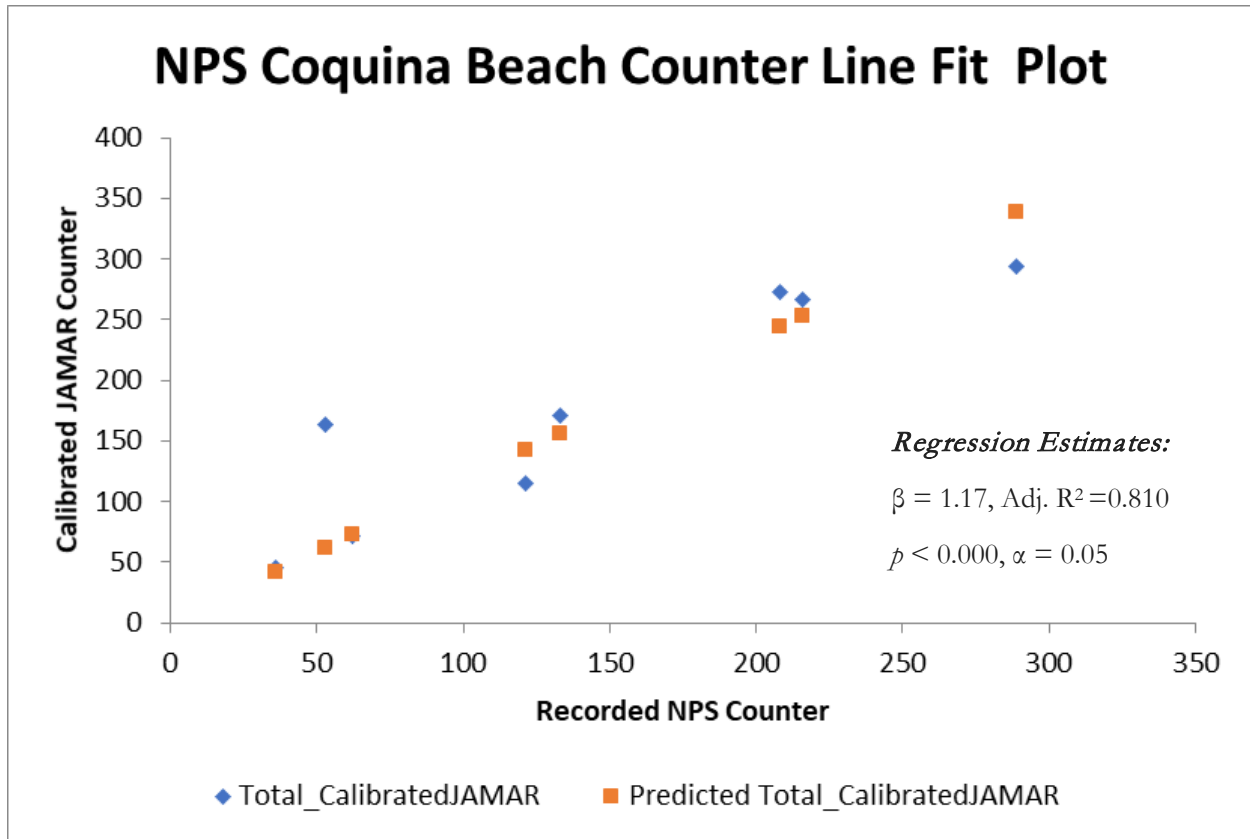


FIGURE 10. NPS COQUINA BEACH COUNTER CALIBRATION ANALYSIS LINE FIT PLOT

Hatteras Island South Counters

Three pneumatic tube traffic counters were deployed to test the feasibility of using JAMAR counters to cordon the main vehicular entrances to beach parking areas for non-ORV beach users on the southern end of Hatteras Island. Each of the counters was deployed in a location that met best practices for counter installation and correspondingly is known to return reliable counts of traffic volumes; therefore, no calibration data were collected for these counters. If deployed in future studies, JAMAR pneumatic tube counters could be used to calculate estimates of overall, inbound vehicles into parking areas at beaches in South Hatteras.

Figure 11, Figure 12, and Figure 13 display graphical summaries of hourly arriving and departing traffic derived from the JAMAR traffic counter data. For each count location in South Hatteras, the average hourly inbound and outbound vehicles are displayed for the period each was deployed during the onsite data collection. It should be noted, only days during which the counters were deployed for a full 24-hour period are included in Figure 11, Figure 12, and Figure 13. At each of the three count locations, vehicles began arriving just before 6:00am, with arrivals and departures occurring concurrently throughout the morning. The arrivals at each location peak around midday, before decreasing throughout the afternoon. Depending on the length of counter deployment, these types of summaries can be generated at the daily, weekly, monthly, or other time scales of interest (e.g., seasonal) to the park.

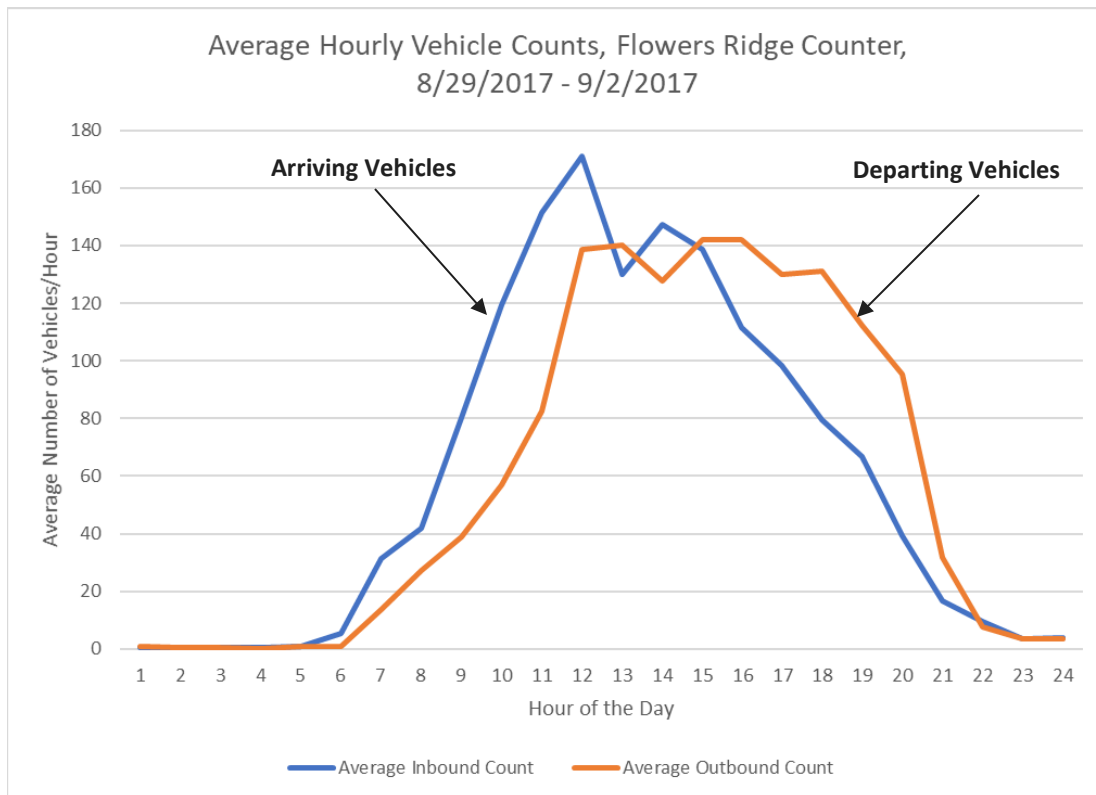


FIGURE 11. AVERAGE HOURLY ARRIVALS AND DEPARTURES, FLOWERS RIDGE ROAD

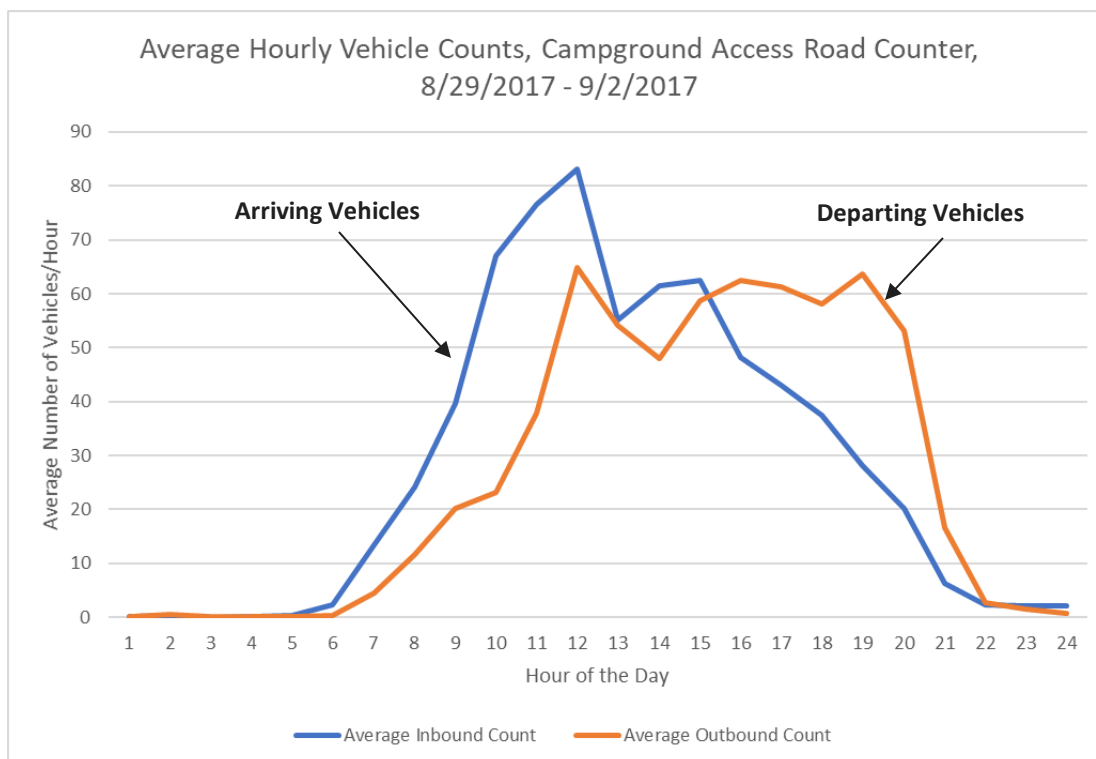


FIGURE 12. AVERAGE HOURLY ARRIVALS AND DEPARTURES, CAMPGROUND ACCESS ROAD

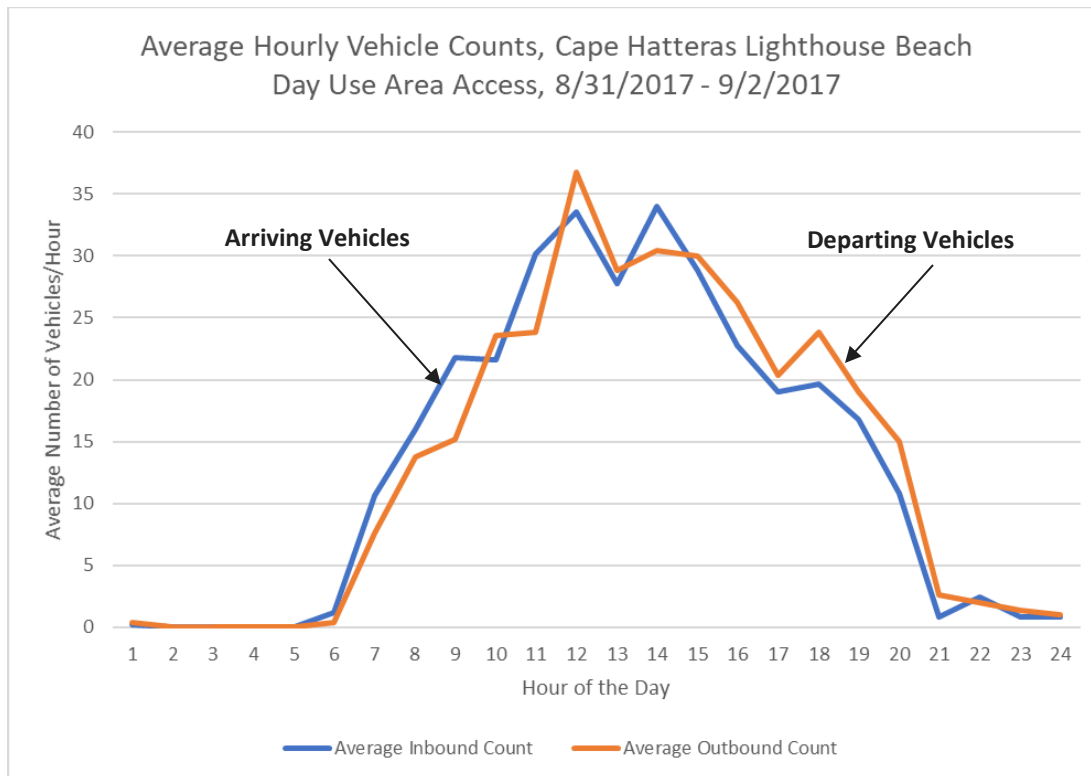


FIGURE 13. AVERAGE HOURLY ARRIVALS AND DEPARTURES, SOUTH HATTERAS DAY USE PARKING ENTRANCE

3.3 | OBSERVATION-BASED COUNTS¹

INTERVAL COUNTS AT BEACH ACCESS POINTS

Pedestrian flow counts were collected at two, vehicle-free beach use areas where deployment of a trail counter was not feasible due to site geography (VFA beach access path across from Little Kinnakeet) or logistical limitations (Ocracoke Day Use area). At Little Kinnakeet there were no shrubs, trees, or wooden poles tall enough or sturdy enough on which to temporarily attach a counter that would record at breast height (the industry standard) for pedestrians. At Ocracoke Day Use, delays caused by the presence of a tropical storm and park closures during the study period resulted in a reduced period for counter deployment, and therefore researcher observation was determined to be an appropriate substitute. These observation counts were conducted to get a sense for the flow of users at these sites.

Observation counts were conducted for a total of three hours at the VFA beach access path across from Little Kinnakeet on Sunday, August 27, 2017. During the approximately three-hour observation period, seven total unique groups were observed entering or exiting the beach, including one group of kiteboarders. Visitor flows at this site averaged approximately one group observation (either arriving or departing) for each 15-minute count period.

¹ Information about observation-based counts conducted to calibrate automated counting equipment is presented in the previous section and not repeated in this section.



Observation counts were conducted at the Ocracoke Day Use Area boardwalk for two hours on Wednesday, August 30, 2017. During the two-hour observation period, the flow of people using the boardwalk to access the beach or parking area was constant; individual people were observed because identifying unique groups from among the steady visitor flow was difficult. During the two-hour period, 140 people entered the beach using the boardwalk and 231 people exited the beach using the boardwalk. People using the boardwalk were often carrying equipment for setting up on the beach, such as chairs, umbrellas, and coolers and many of the people observed seemed to be in family groups with children.

At the Ocracoke Day Use Beach Area, an additional beach access path was identified near the visitor facilities. This beach access path was also observed for inbound and outbound use. During the two-hour observation period, only one person was seen using this path. This suggests that if total inbound and outbound counts of use were conducted at Ocracoke Day Use Area in a future study, counting only at the boardwalk would capture most inbound traffic to the beach with the traffic at the other path being nominal.

INSTANTANEOUS (AT-ONE-TIME) COUNTS ON BEACHES

A near-instantaneous count of people-at-one-time and vehicles-at-one-time was conducted at Cape Point on Friday, September 1, 2017, from approximately 1:00pm – 2:00pm, with the count itself taking approximately 25 minutes to complete. This count was conducted to determine the feasibility and accuracy of conducting simultaneous counts of people and vehicles on the beach with one study administrator in one of the park's busiest beach areas. This information is integral to accurately scoping and staffing this type of data collection procedure for future visitor use studies at CAHA. This type of data collection requires precision, which can be impacted by site complexity and user behaviors. Therefore, we wanted to test these protocols to understand what would be realistic in a dispersed use area such as Cape Point.

The following three counts were simultaneously conducted: vehicles-at-one-time, people-at-one-time affiliated with a vehicle, people-at-one-time not affiliated with a vehicle. The distinction between the two types of people was made to differentiate between user types on the beach: those using a vehicle and those without a vehicle. Due to the volume of people on the beach during the count period, RSG's study administrator found it difficult to accurately record the three counts simultaneously. Given this experience, modification of protocols would be necessary to separate the count into two components (i.e., a count of vehicles and a count of the two types of people) that can be conducted by two staff members simultaneously, with each staff member being assigned one component of the instantaneous count (either vehicles or people). Additionally, the Cape Point area would need to be divided into easily identifiable counting regions allowing for transparency in data collection procedures and repeatability both during the collection period and in any follow-up studies or use monitoring that might be done using at-one-time counts in this area.

VEHICLE COUNTS IN BEACH PARKING LOTS

Vehicle counts were conducted at the Coquina Beach parking lot as a test location for this type of data collection, which could be applied to other beach parking areas in potential future studies. There were few vehicles entering the Coquina Beach parking lot on the day on which this data collection procedure was scheduled. Therefore, further pretesting would be needed to determine how long it would take a study administrator to conduct a complete cycle of counting and recording license plates during peak parking conditions.

Overall, several types of observation-based counts were conducted of people and vehicles in CAHA during the onsite data collection period. These observation-based counts were conducted to determine the feasibility of their use in future studies, where their implementation may be used to collect baseline, descriptive information about the number of people and vehicles at a given park location for a given measure of time. These types of measures are useful in estimating beach use at specific locations, parkwide, and in relation to potential indicator or proxy counts (e.g., parking lot counts, traffic counts, boardwalk counts, aerial-based counts, hotel and rental property occupancy rates, etc.).



4.0 CAHA VISITOR USE AND SOCIAL SCIENCE RESEARCH PLAN

This section presents RSG's recommendations regarding a visitor use and social science research plan for CAHA. RSG's recommendations are based directly on input from OBG management regarding their highest priority research questions and information needs for park planning, management, and operations. RSG's recommendations are also informed by the onsite scoping and exploratory data collection conducted in CAHA during summer 2017, which served as a pilot test for the research concepts and methods specified in the recommendations.

RSG recommends a visitor use and social science research plan for CAHA to include the following five studies:

1. CAHA Parkwide Beach Use Estimation Study.
2. CAHA Parkwide Visitor Survey.
3. CAHA Parkwide Visitor Survey: Public Use Statistics Module.
4. CAHA Beach Users Study: ORV Beaches.
5. CAHA Beach Users Study: VFA Beaches.

Results from implementing this research plan would include the following products:

- Parkwide proxy counting and beach use monitoring system.
- Parkwide visitor profiles, including motivations, activities, trip planning, expenditures, use patterns, and demographics.
- Up-to-date multipliers for more accurate public use statistics.
- Beach use and user profiles to support implementation of the ORV Management Plan and inform decisions about facilities, services, and staffing at ORV, VFA, and other beaches.

Implementation of this research plan in CAHA would serve critical information needs for park policy, planning, management, and operations.

The rest of this section provides detailed descriptions and ROM cost estimates for each of the five studies recommended by RSG. The ROM cost estimates are based on Federal Fiscal Year 2018 rates and are subject to an escalation rate of approximately 4% per year. All other assumptions regarding the ROM cost estimates are included with the cost estimates themselves.

4.1 | CAHA PARKWIDE BEACH USE ESTIMATION STUDY

Purpose: Through three phases of work, this project would test and identify aerial photography-based and on-the-ground proxy counts and locations in CAHA that could be used to generate statistically reliable estimates of parkwide ORV and non-ORV beach use². The project would develop a counting system to provide the park with an efficient and reliable mechanism for monitoring parkwide beach use on an ongoing basis.

² The study would generate estimates of the number of people and ORV's on beaches, at one time, for monitoring purposes. Additional research would be required to estimate overall beach visitation.

Outcome: The long-term counting and beach use monitoring system developed from this project would serve critical information needs for park policy, planning, management, and operations. Specific results of this project would include:

- Proxy count locations and protocols for beach use monitoring.
- Multipliers to estimate beach use from proxy counts.
- Beach use estimates for study areas during the study period.
- Reporting and data summary templates for long-term beach use monitoring.

Recommended Implementation Approach: As noted, this project would be implemented in three phases. In each phase of work, aerial photography-based counts would be conducted and on-the-ground automated count equipment would be deployed and calibrated at potential proxy count locations. Concurrently, staff-intensive, sampling-based hourly and daily observation counts would be conducted on beaches in CAHA. In each phase, analyses would be conducted to explore for statistically reliable relationships among the observation-based beach use counts, automated on-the-ground counts at proxy count locations, and aerial photography-based counts. Through the three phases of the project, data collection and analyses would be progressively applied to increasingly larger and complex spatial scales, culminating in a parkwide system of proxy counts and beach use monitoring procedures. The three phases of the project are described in more detail below.

Phase 1: Observation-based hourly and daily interval counts, automated on-the-ground equipment-based proxy counts, and aerial photography-based counts would be conducted concurrently at one high-use beach, selected to serve as a pilot test for understanding the efficacy and feasibility of each type of data collection at CAHA. Analysis of Phase 1 data would focus on exploring for statistically reliable relationships among the observation-based beach use counts, automated on-the-ground counts at the proxy count location, and aerial photography-based counts. Phase 1 results would be reported in a technical memo and used to inform the design and conduct of Phase 2 of the project.

Phase 2: Data collection and analysis would serve as a second phase of pilot testing, with focus on refining the most effective methods from Phase 1 and applying them to a larger and more complex spatial scale in CAHA. On-the-ground proxy count locations and procedures would be identified for three to five high-use beaches in CAHA. Observation-based hourly and daily interval counts, automated on-the-ground equipment-based proxy counts, and aerial photography-based counts would be conducted concurrently. Analysis of Phase 2 data would focus on exploring for statistically reliable relationships among the observation-based beach use counts, automated on-the-ground counts at proxy count locations, and aerial photography-based counts within and across the study beaches. Phase 2 results would be reported in a technical memo and inform the pilot implementation of aerial-based or on-the-ground proxy count methods and locations to apply parkwide in Phase 3.

Phase 3: The most robust and reliable data collection and analysis methods derived from the first two phases of this project would be applied in a staff- and resource-intensive, parkwide application. This would include a combination of aerial photography-based or on-the-ground proxy counts collected concurrently with observation-based beach use counts at locations throughout CAHA. Analysis of the Phase 3 data would provide a first-generation estimate of parkwide beach use. The Phase 3 results would be reported in a technical memo and provide the basis for a counting and estimation system for long-term monitoring of parkwide beach use in CAHA.



ROM Cost Estimate (Phase 1): \$185,000³

Assumptions (Phase 1):

- Scoping, training, and data collection at one (1) high-use beach in CAHA during the peak summer season.
- 3-day scoping, training, and equipment deployment (1 trail or traffic counter) period.
- 1-day aerial photography logistics/coordination period.
- 9 days of observation-based beach use counts.
- 10 hours of calibration counts at the trail or traffic counter location.
- 1 peak hour aerial photography flight of CAHA (assumes 70-mile shoreline, for parkwide overflight, including study area beach).
- Field team staff to include:
 - 1 Senior Social Scientist (3 days onsite).
 - 2 Staff Social Scientists (6 days onsite).
 - 1 Interview Specialist 3 (roving; 13 days onsite).
 - 4 Interview Specialist 1 (13 days onsite).
- Processing of aerial photography data for the study area beach (assumes 5-mile shoreline).
- Descriptive summaries and exploratory analyses of statistical relationships.
- Deliverable: Draft and final report.

ROM Cost Estimate (Phase 2): Contingent on findings from Phase 1

ROM Cost Estimate (Phase 3): Contingent on findings from Phase 1 and Phase 2

4.2 | CAHA PARKWIDE VISITOR SURVEY

Purpose: This project would collect information about visitor use and users from a parkwide sample of all CAHA visitors. This would be the first parkwide survey of CAHA visitors in more than 10 years and since the park's ORV Management Plan was completed. Thus, the project would address the park's need for up-to-date parkwide visitor profiles, including motivations, activities, trip planning, expenditures, use patterns, and demographics.

Outcome: The information collected in this project would be applicable to virtually all park planning and management efforts in CAHA, and help address the park's highest priority research questions. Specific information collected in this project would include CAHA parkwide visitors':

- Personal, group, and CAHA trip characteristics.
- Motivations for visiting CAHA, and information used to plan their visits.
- Activities participated in and locations visited in CAHA, the other OBG park units, and the Outer Banks area.
- Use and evaluation of facilities, services, and programs in CAHA.
- Expenditures in CAHA and the nearby area.
- Attitudes regarding management of visitor use in CAHA.

³ Marginal cost for additional overflights, including aerial photography data processing, is approximately \$4,500 per overflight.

Recommended Implementation Approach: Ideally, visitors would be intercepted for the survey using a combination of a vehicle-based intercept at Whalebone Junction and a ferry-based intercept on the Swan Quarter and Cedar Island ferries; this would be the most direct, comprehensive, and cost-effective method to obtain a parkwide sample of all CAHA visitors. Moreover, conducting an intercept at Whalebone Junction would provide an opportunity to concurrently collect information to update and improve the accuracy of CAHA's public use statistics, as described below. However, questions and concerns exist about the safety, feasibility, and potential impacts to the local community of implementing a vehicle-based, roadway intercept at Whalebone Junction.

Correspondingly, this project could involve an initial scoping and testing phase to assess the feasibility of conducting roadway intercepts at Whalebone Junction, if the NPS wished to collect public use statistics-related information concurrently with administering the visitor survey. Survey implementation would be conducted in a second phase, using recommendations from Phase 1 regarding the most cost-efficient and administratively feasible sampling methods to obtain a parkwide sample of all CAHA visitors. If the NPS preferred not to sample at Whalebone Junction at all, it would not be necessary to conduct the initial scoping and testing phase at Whalebone Junction. In either case, each phase is described in this section.

Optional Phase 1 (Scoping and Testing): This phase is only necessary if the NPS wishes to assess the feasibility of survey sampling at Whalebone Junction. Site scoping and testing of roadway intercepts would be conducted during a 2-day onsite period at Whalebone Junction on NC HWY 12 just south of the intersection with US-64 but prior to arrival at the Information Station (Figure 14). During site scoping, safety treatments would be installed in coordination with NPS and local officials, including temporary and portable speed bumps for traffic-calming, and orange traffic cones to narrow traffic lanes and direct arriving vehicles onto the wide shoulder for sampling. These roadway treatments, along with potential onsite presence of NPS Law Enforcement, would be in place for up to two days to test roadway intercept procedures.



FIGURE 14. WHALEBONE JUNCTION NORTHBOUND (LEFT) AND SOUTHBOUND (RIGHT) VIEWS

During the testing period, two staff social scientists dressed with traffic safety vests and using handheld Slow/Stop signs would conduct roadway intercepts on an interval basis and conduct a brief (2 to 3 minute) interview with drivers of intercepted vehicles to collect basic descriptive information (e.g., recreation versus nonrecreation trip purpose, vehicle occupancy, place of residence, CAHA trip length). Results of the onsite



scoping and testing would be reported in a technical memo, and include recommendations regarding the most cost-efficient and administratively feasible method to obtain a representative sample of all CAHA visitors.

Phase 2 (Implementation): Visitors would be recruited for participation in this study via onsite intercepts, and willing participants would be asked to complete a self-administered mail-back survey questionnaire at the end of their visit to CAHA. As noted, sampling via a vehicle-based intercept at Whalebone Junction and a ferry-based intercept on the Swan Quarter and Cedar Island ferries is recommended, if the NPS wishes to concurrently collect information to update and improve the accuracy of its public use statistics, as described below. Alternatively, it would be possible to replicate the survey sampling procedures from the 2002 Visitor Services Project study at CAHA, in which visitors were intercepted at nine locations throughout the seashore.

The cost for obtaining a representative sample of all CAHA visitors would be roughly the same whether the 2002 VSP sampling procedures were replicated or sampling was conducted at Whalebone Junction and on the Swan Quarter and Cedar Island ferries. Sampling at Whalebone Junction and on the ferries would have the benefit of providing the option of concurrently collecting public use statistics-related information, and would minimize sampling bias for generalizing visitor survey results to CAHA visitors parkwide. The ROM cost estimate presented below assumes scoping, training, and sampling would occur on 12 consecutive days during the summer season. Optional sampling could also be conducted across seasons, based on park priorities and funding; sampling across seasons would allow for producing statistically reliable results for separate seasons in CAHA, but would be substantially more costly than a study of beach users during a single season (e.g., peak summer season).

ROM Cost Estimate (Optional Phase 1: Scoping and Testing): \$9,000

Assumptions (Optional Phase 1: Scoping and Testing):

- 2-day onsite scoping and testing period at Whalebone Junction during the peak summer season.
- 2 Staff Social Scientists (2 days onsite).
- Roadway treatments and traffic management equipment provided by NPS.
- Conducted in conjunction with CAHA Parkwide Beach Use Estimation Study Phase 1 to minimize travel expenses.
- Deliverable: Draft and final technical memo.

ROM Cost Estimate (Phase 2: Implementation): \$155,000

Assumptions (Phase 2: Implementation):

- Scoping, training, and survey sampling.
- 3 scoping and training days.
- 9 sampling days.
- Target of 800 questionnaires distributed onsite.
- Target of 400 completed questionnaires.
- Field team staff to include:
 - 2 Staff Social Scientists (6 days onsite).
 - 1 Interview Specialist 3 (roving; 13 days onsite).
 - 4 Interview Specialist 1 (2 at Whalebone Junction, 1 each on ferries; 13 days onsite).
- Onsite intercept to administer paper-based mail-back survey.

- Parkwide analysis and results report.
- <1.5% data entry error rate, including “write in” responses.
- Deliverable: Draft and final report.

4.3 | CAHA PARKWIDE VISITOR SURVEY: PUBLIC USE STATISTICS MODULE

Purpose: This project would be implemented as a supplemental module to the CAHA Parkwide Visitor Survey, if survey sampling is conducted at Whalebone Junction. Information would be collected from all visitors contacted for the parkwide survey (survey respondents and nonrespondents) to update and improve the accuracy of the park’s public use statistics. Data collected in this project would be analyzed and reported in a format that allows for the results to be directly incorporated into the park’s existing visitor counting and public use statistics procedures.

Outcome: The results of this project would improve park visitation estimates and related public use statistics, which are fundamental to a broad range of park planning and management issues. Specific information that would be collected as part of this project includes trip purpose (i.e., recreation or nonrecreation), trip length in CAHA (hours or days), and vehicle occupancy. Specific results of this project would include:

- Persons per vehicle multiplier(s).
- Recreation and nonrecreation multipliers.
- Length of stay multipliers.
- Overnight stay multipliers.

Recommended Implementation Approach: As noted, this project would be conducted concurrently with the CAHA Parkwide Visitor Survey, if survey sampling is conducted at Whalebone Junction. If the public use statistics module were to be implemented, a small number of additional questions would be asked of each visitor group intercepted at Whalebone Junction for the parkwide survey.

ROM Cost Estimate: \$15,000

Assumptions:

- Conducted at Whalebone Junction in conjunction with the CAHA Parkwide Visitor Survey; no additional staff, sampling days, or travel expenses required.
- Data collection via additional information fields on CAHA Parkwide Visitor Survey contact log form.
- <1.5% data entry error rate, including “write in” responses.
- Deliverable: Draft and final supplemental section within the CAHA Parkwide Visitor Survey report.

4.4 | CAHA BEACH USERS STUDY: ORV BEACHES

Purpose: This project would collect information from a sample of visitors using beaches where ORV use is permitted in CAHA. The project could focus specifically on sampling visitor groups with ORVs on the beach or sample from all visitor groups on ORV beaches whether they have an ORV on the beach or not. The information collected in this project would be a key component of the park’s implementation of the ORV Management Plan for monitoring and managing visitor use on ORV and other beaches in CAHA.

Outcome: This project would help address the park’s highest priority research questions, inform decisions about the relative amount of facilities, services, and park staff presence to provide at ORV and other beaches,



and be an important component of implementing the ORV Management Plan. More specifically, this project would collect information from a sample of beach users on ORV beaches about their:

- Personal, group, and trip planning characteristics.
- Motivations for using ORV beaches and for visiting CAHA.
- Activities while using ORV beaches.
- Other activities they engage in and locations they visit during their visit to CAHA.
- Use of and preferences for park facilities at ORV beaches.
- Frequency and duration of visits to ORV beaches.
- Perceptions of, tolerances for, and attitudes regarding management of visitor use on ORV beaches and other beaches in CAHA.

Recommended Implementation Approach: Visitors would be recruited for participation in this study via onsite intercepts on a sample of ORV beaches in CAHA. Participants would be asked to complete a self-administered mail-back survey questionnaire at the end of their visit to CAHA. To strike a balance between project costs and the statistical reliability of study results, sampling would target relatively high-use ORV beaches, days, and times of day to maximize sampling efficiency. Sampling would occur at ORV beaches in each of four data collection regions in CAHA, with one beach sampled per day per region for parkwide coverage.

More intensive sampling could be conducted, based on park priorities and funding, to sample at a larger number of ORV beaches or for more days. More intensive sampling would allow for producing statistically reliable results for separate beach or beach user segments (rather than just parkwide analysis and reporting), but be substantially more costly than the base sampling design. Optional sampling could also be conducted across seasons, which would allow for producing statistically reliable results for separate seasons in CAHA, but would be substantially more costly than a study of beach users during a single season (e.g., peak summer season).

ROM Cost Estimate (Stand-alone⁴): \$155,000

Assumptions (Stand-alone):

- Scoping, training, and survey sampling in each of 4 data collection regions in CAHA during the peak summer season.
- 3 scoping and training days.
- 9 sampling days, 1 ORV beach per day for each of the 4 data collection regions.
- 2 to 3 sampling locations (ORV beaches) total per data collection region.
- Target of 250 questionnaires distributed per data collection region, 1,000 total.
- Target of 100 completed questionnaires per data collection region, 400 total.
- Field team staff to include:
 - 2 Staff Social Scientists (6 days onsite).
 - 1 Interview Specialist 3 (roving; 13 days onsite).

⁴ The ROM cost estimate for conducting the CAHA Beach Users Study concurrently at ORV beaches and VFA beaches in a single sampling season is \$275,000. This would constitute a roughly \$25,000 savings over conducting each as a stand-alone study during two separate sampling seasons.

- 4 Interview Specialist 1 (1 per data collection region; 13 days onsite).
- Onsite intercept to administer paper-based mail-back survey.
- Parkwide analysis and results report.
- <1.5% data entry error rate, including “write in” responses.
- Deliverable: Draft and final report.

4.5 | CAHA BEACH USERS STUDY: VFA BEACHES

Purpose: This project would collect information from a sample of visitors using VFA beaches in CAHA. The project would provide baseline information about uses and users of VFA beaches, and correspondingly serve as a key component of the park’s implementation of the ORV Management Plan for monitoring and managing visitor use on VFA and other beaches in CAHA.

Outcome: This project would help address the park’s highest priority research questions, inform decisions about the relative amount of facilities, services, and park staff presence to provide at VFA and other beaches, and be an important component of implementing the ORV Management Plan. More specifically, this project would collect information from a sample of beach users on VFA beaches about their:

- Personal, group, and trip planning characteristics.
- Motivations for using VFA beaches and for visiting CAHA.
- Activities while using VFA beaches.
- Other activities they engage in and locations they visit during their visit to CAHA.
- Use of and preferences for park facilities at VFA beaches.
- Frequency and duration of visits to VFA beaches.
- Perceptions of, tolerances for, and attitudes regarding management of visitor use on VFA beaches and other beaches in CAHA.

Recommended Implementation Approach: Visitors would be recruited for participation in this study via onsite intercepts on a sample of VFA beaches in CAHA. Participants would be asked to complete a self-administered onsite survey questionnaire at the time they are contacted. To strike a balance between project costs and the statistical reliability of study results, sampling would target relatively high-use VFA beaches, days, and times of day to maximize sampling efficiency. Sampling would occur at VFA beaches in each of four data collection regions in CAHA, with one beach sampled per day per region for parkwide coverage.

More intensive sampling could be conducted, based on park priorities and funding, to sample at a larger number of VFA beaches or for more days. More intensive sampling would allow for producing statistically reliable results for separate beach or beach user segments (rather than just parkwide analysis and reporting), but be substantially more costly than the base sampling design. Optional sampling could also be conducted across seasons, which would allow for producing statistically reliable results for separate seasons in CAHA, but would be substantially more costly than a study of beach users during a single season (e.g., peak summer season).

ROM Cost Estimate (Stand-alone⁵): \$145,000

⁵ The ROM cost estimate for conducting the CAHA Beach Users Study concurrently at ORV beaches and VFA beaches in a single sampling season is \$275,000. This would constitute a roughly \$25,000 savings over conducting each as a stand-alone study during two separate sampling seasons.



Assumptions (Stand-alone):

- Scoping, training, and survey sampling in each of 4 data collection regions in CAHA during the peak summer season.
- 3 scoping and training days.
- 9 sampling days, 1 VFA beach per day for each of the 4 data collection regions.
- 2 to 3 sampling locations (VFA beaches) total per region.
- Target of 250 questionnaires distributed per region, 1,000 total.
- Target of 100 completed questionnaires per region, 400 total.
- Field team staff to include:
 - 2 Staff Social Scientists (6 days onsite).
 - 1 Interview Specialist 3 (roving; 13 days onsite).
 - 4 Interview Specialist 1 (1 per region; 13 days onsite).
- Onsite intercept and survey completion.
- Parkwide analysis and results report.
- <1.5% data entry error rate, including “write in” responses.
- Deliverable: Draft and final report.



APPENDIX A. LIST OF PREVIOUSLY CONDUCTED STUDIES REVIEWED TO INFORM VISITOR USE AND TRAVEL STUDY PHASE 1

Management Analysis, Incorporated. (2015). *Visitor survey 2014-2015 the Outer Banks Visitors Bureau: Volume 1 visitor survey report* (Research Report). Retrieved from Cape Hatteras National Seashore, personal communication.

Mansfield, C., Loomis, R., Evans, B., & Munoz, B. (2010). *Ramp counts: Off-road vehicle management, Cape Hatteras National Seashore: Final Report* (Research Report). Retrieved from Cape Hatteras National Seashore, personal communication.

Mansfield, C., Loomis, R., Evans, B., & Munoz, B. (2010). *Visitor intercept survey: Off-road vehicle management, Cape Hatteras National Seashore: Final Report* (Research Report). Retrieved from Cape Hatteras National Seashore, personal communication.

Park Studies Unit, University of Idaho. (2003). Outer Banks Group Parks: Cape Hatteras National Seashore, Fort Raleigh National Historic Site, Wright Brothers National Memorial Visitor Study (Research Report 136b). Retrieved from Cape Hatteras National Seashore, personal communication.

Strother, J. A., & Vogelsong, H. (2003). Carry capacity and visitor experience: Cape Hatteras National Seashore. *Proceedings of the 2002 Northeastern Recreation Research Symposium GTR-NE-302*: 229-233.

Vogelsong, H. (2003). *Cape Hatteras National Seashore visitor use study* (Research Report). Retrieved from Cape Hatteras National Seashore, personal communication.