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Ramp Counts: Off-Road Vehicle Management

Cape Hatteras National Seashore

Final Report

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Contents

Figure

Number **Page**

Tables

1 Introduction and Survey Goals

The National Park Service (NPS) is in the process of developing an Off-Road Vehicle (ORV) Management Plan for the Cape Hatteras National Seashore (the Seashore). Under the National Environmental Policy Act, NPS must complete an Environmental Impact Statement (EIS) and as part of the rulemaking process NPS must conduct a benefit-cost analysis of the proposed and final regulation (Executive Order [E.O.] 12866, as amended by E.O. 13258 of February 26, 2002, and E.O. 13422 of January 18, 2007).

To support the analyses and to collect information relevant to park management, NPS contracted with RTI International to count vehicles accessing the Seashore through the ocean-side access ramps. As part of the vehicle count, we also counted visitors on selected beaches at selected times of the day. The two noncontact surveys involved counting the number of vehicles using the ocean-side beach access ramps in the Seashore and counting the visitors during the day on selected beaches in the Seashore to estimate the density of beach use (visitors per mile) throughout the day. The vehicle and beach visitor counts will provide an estimate of the size and spatial distribution of ORV use and visitor distribution within the Seashore.

The final EIS (FEIS) includes two no-action alternatives (NPS, 2010). Conditions in 2007 under the Interim Protected Species Management Strategy (the Interim Strategy, NPS, 2006) define no-action Alternative A and conditions under the Consent Decree (see a summary of the Consent Decree at http://www.nps.gov/caha/planyourvisit/consentdecree.htm), which went into place in the spring of 2008, define no-action Alternative B. The data from the counting surveys will provide

information about conditions in the Seashore between April 2009 and March 2010. The estimates of use during that 12-month period will be applicable to no-action alternative B.

1.1 GOALS

The primary goals of the Noncontact Vehicle Counting Survey were to

- estimate the total number of vehicles using the 17[1] ocean-side ramps during a 12-month period between 6 a.m. and 10 p.m. and
- estimate the density of visitors (the number of visitors per mile) at different times of day using selected ocean-side beaches during a 12-month period between 6 a.m. and 10 p.m.

The count of vehicles provides information about use at different ramps; however, the number of vehicles and the number of passengers in those vehicles are not comparable to the official visitation statistics maintained by NPS. A visitor using the ramps could make several roundtrips over the ramps in a day and would result in counting the same visitor multiple times.

[1] Counting was done at 16 ramp entrance points. Ramps 44 and 45 share an entry point, so the count for ramp 44 includes ramp 45.

2 Background

The Seashore spans three islands (Bodie, Hatteras, and Ocracoke) and portions of two counties (Dare and Hyde) on the Outer Banks of North Carolina. With the Town of Nags Head located directly to its north, the Seashore encompasses eight small villages (Rodanthe, Salvo, Waves, Avon, Buxton, Frisco, Hatteras, and Ocracoke) that are surrounded by but excluded from the Seashore boundary. Pea Island National Wildlife Refuge, managed separately by the Fish and Wildlife Service, is located on northern Hatteras Island, and Hatteras Island's Cape Point is home to the historic Cape Hatteras Lighthouse. The Seashore is a popular tourist destination for swimmers, fishers, surfers, kite surfers, and general beach goers.

2.1 PRIOR COUNTS OF VEHICLE USE ON THE OCEAN-SIDE BEACHES IN THE SEASHORE

The Seashore has collected data on ORVs using several different methods including flyovers, infrared traffic counters, and in-person counts. Flyovers capture a snapshot of ORVs on the beach at a point in time. They do not provide an estimate of the total number of vehicles on the beach on a given day. On Memorial Day and July 4th in many years, the park counted the number of ORVs on the beach by an aerial survey conducted from a small plane flying over the Seashore. Figure 2-1 displays the counts from recent years (there were no data for Memorial Day 2003). Visitation to the Seashore varies year to year depending on many factors including weather and economic factors. The flyover counts display this variability. For example, in 2006 and 2007, the count recorded more vehicles on the beach on Memorial Day than on July 4th, but in 2003, 2005 and 2008 it was the opposite. The total number of vehicles counted on any day varied from 1,000 to over 3,000.

Figure 2-1. Aerial Counts of ORVs on Fourth of July and Memorial Day 2003 - 2008

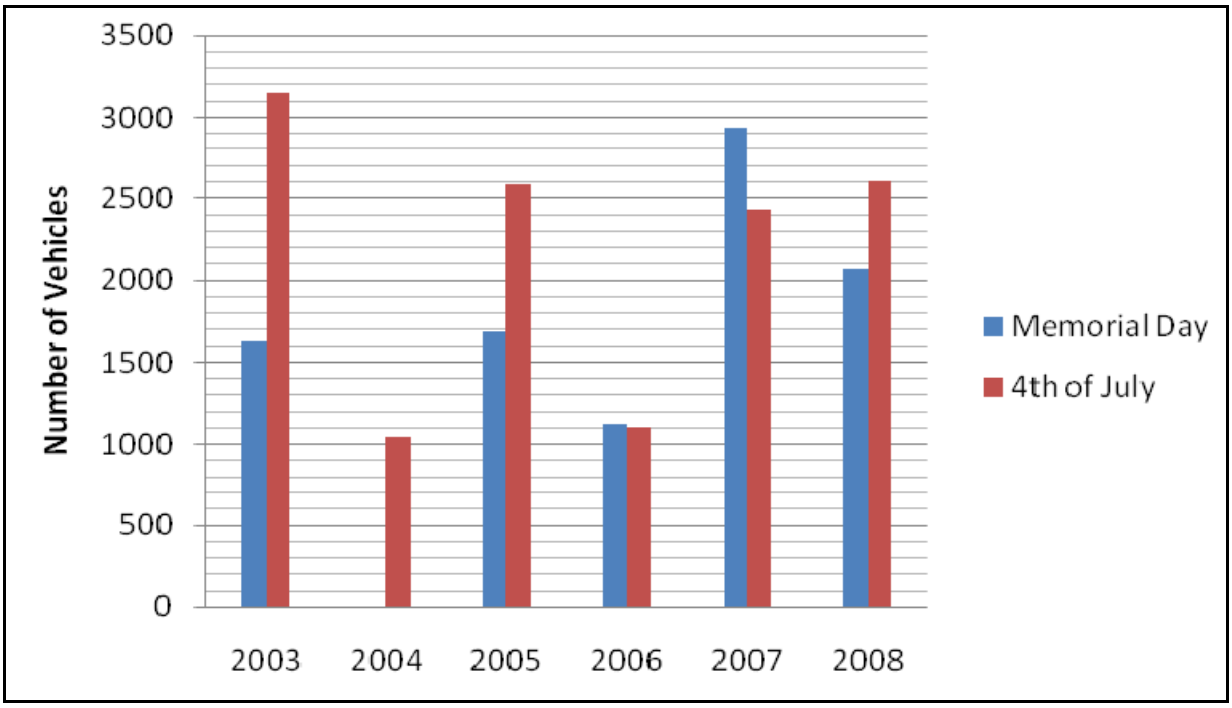

Table 2-1 provides a breakdown of the distribution of ORVs along the Seashore in 2008. On both holidays, ramps 4 and 43 through 49 had the highest number of vehicles.

Table 2-1. Aerial Ramp Counts for Fourth of July and Memorial Day, 2008

Memorial Day		July 4th
Ramp	**Count**	**Count**
Ramp 4	641	661
Ramp 23–27	336	353
Ramp 27–38	191	277
Ramp 43–49	471	758
Ramp 55	137	230
Ocracoke	293	300
2008 Total Count	**2,069**	**2,579**

Source: Trevino pers. comm. 2010

The second source of data on ORV use comes from remote sensor portable traffic counters installed by the Seashore at ORV ramps. These counters were mounted on two posts at the entrance to a ramp. The counter, mounted on one post, projected an infrared (invisible) light beam across the entrance to a reflector mounted on the opposite post. The counter tallied the number of times the beam of light was broken. The counters count anything that breaks the beam, including pedestrians, rain, and uncut plants. The counters must be properly aligned to count, and they can also malfunction and fail to register counts.

Although the infrared counters produced reliable data for some days, we did not have enough reliable data to estimate yearly use with confidence. During the pilot test of the noncontact counting methods, field staff compared their numbers with the numbers from the mechanical counters. At all but two of the ramps, RTI staff were able to evaluate and compare the numbers recorded by the infrared counter with actual hand counts conducted by RTI staff during the same period. Table 2-2 provides a comparison of the hand counts and the numbers from the infrared counters. The ramp counters overestimated the number of ORVs by 24% to 157%. In another physical count of ramp use at two pedestrian accessible ramps [2], Ramps 23 and 27, pedestrians accounted for 30% and 63% of the counts, respectively.

Finally, Vogelsong (2003) conducted counts of vehicles during a visitor survey that took place between May 2001 and May 2002. Vogelsong estimates that 73,526 to 110,288 used the beach between 2001 and 2002 when the park received an average of 2,758,392 visitors. Based on these figures, he estimated that ORVs represent approximately 2.7 to 4.0 percent of all visitors to the park. The final report does not describe how the sampling locations and times were selected, how the counting was done, or how the final estimates were derived (what type of weights, if any, were used). Without more information about the counts, it is not clear whether the numbers from the Vogelsong study are comparable to the numbers derived from RTI's vehicle count, which represents roundtrips and not unique visitors.

[2] Ramps were designated "pedestrian accessible" if pedestrians could easily walk across the ramp to the beach based on the judgments of RTI staff with input from Seashore staff and local residents.

Table 2-2. Vehicle Counts from RTI Pilot Test Compared to Infrared Counter Tally

Date	Ramp	Start	End	Total Vehicles Counted by Staff	Total Vehicles Counted by Counter	Difference between Counter and Staff Count
10/17	4	7:35a	9:58a	75	97	22
10/17	23	12:36p	2:50p	37	46	9
10/18	44	10:30a	12:38p	113	290	177
10/18	44	8:38a	10:02a	92	114	22
10/18	49	6:00p	7:00p	12		
10/16	55	6:00p	7:10p	51	63	12
10/16	72	12:45p	2:55p	60		
10/16	72	12:50p	3:00p	59		

The Vogelsong report was peer-reviewed by outside experts for NPS (Gramann, 2008). The conclusion of the experts was summarized as follows:

> The panel commented that the design of the Vogelsong study served certain purposes well, such as documenting attitudes of park visitors and comparing ORV users with non-ORV users. However, all reviewers felt that insufficient detail was provided on the sampling methods and analysis in the Vogelsong report for them to reliably determine the extent to which ORVs use the Seashore.

3 Sample Design for Vehicle and Visitor Counting Surveys

3.1 SURVEY SAMPLING FRAME

3.1.1 Vehicle Counting

The population of interest for the Noncontact Vehicle Counting Survey consists of all vehicles using open ocean-side beach access ramps in the Seashore during a 12-month period from 6 a.m. to 10 p.m. The sampling frame includes all possible combinations of time (day and time of day) and location (ramp). The actual sample is drawn from the sampling frame.

Table 3-1 lists the ramps in the sampling frame for this project, which consists of the seventeen ocean-side ORV access ramps that currently operate in the Seashore. Two of the ramps are located on Bodie Island, 10 are on Hatteras Island, and the remaining 5 are on Ocracoke. Six ramps provide primary access to spits and points that are popular fishing destinations and 8 ramps provide the primary outlet for a village. The number of vehicles using a ramp is believed to be associated with visitation to the island where the ramp is located, whether the ramp provides access to a spit or point, and whether the ramp is the primary outlet for an adjacent village. In addition, some beach ramps lead to known or predicted shorebird nesting areas, defined under some action alternatives as "species management areas", that will likely be subject to more intensive management for protected species (NPS, 2008). Use of the ramps leading to such areas will vary depending on closings and openings for resource protection during the spring, summer, and fall.

Table 3-1. ORV Ramps Included in the Sampling Frame

Ramp	Island	Cluster	Primary Access to a Spit or Point?	Primary ORV access point for adjacent Village?
Ramp 2	Bodie	1	No	No
Ramp 4	Bodie	1	Yes	No
Ramp 23	Hatteras	2	No	Yes
Ramp 27	Hatteras	2	No	No
Ramp 30	Hatteras	2	No	No
Ramp 34	Hatteras	3	No	Yes
Ramp 38	Hatteras	3	No	Yes
Ramp 43	Hatteras	4	Yes	Yes
Ramp 44/45	Hatteras	4	Yes	No
Ramp 49	Hatteras	5	No	Yes
Ramp 55	Hatteras	5	Yes	Yes
Ramp 59	Ocracoke	6	Yes	No
Ramp 67	Ocracoke	6	No	No
Ramp 68	Ocracoke	7	No	No
Ramp 70	Ocracoke	7	No	Yes
Ramp 72	Ocracoke	7	Yes	Yes

3.1.2 Visitor Counting

The sampling frame for the Noncontact Visitor Counting Survey consists of visitors on lifeguarded beaches, the ocean-side beaches in front of villages, and beach segments within 0.5 mile of pedestrian-accessible ramps during a 12-month period from 6 a.m. to 10 p.m.

Table 3-2 lists the beaches in the sampling frame. The three lifeguarded beaches located in the study area are Coquina Beach, Lighthouse Beach, and Ocracoke Beach. The village beaches are defined as the ocean-side beaches in front of villages. Finally, the ramp beaches encompass the beach stretching 0.5 mile on either side of the mouth of the ramp at ramps that are pedestrian accessible or have pedestrian boardwalks located nearby (ramps 2, 23, 27, 30, 34, 38, 43, 55, 59, and 70). Lifeguarded beaches, village beaches, and ramp beaches were divided into 0.25-mile segments. This segmentation created 114 segments and captured

approximately 27.1 miles of ocean-side beach out of the entire 68 miles of beach discussed in the Routes and Areas Table 7 in the DEIS (NPS, 2008). The segments in beach (a lifeguard beach, a village beach, or a ramp beach) are lettered starting with A for the northern-most section of the beach and moving south.

The beach sampling frame does not include ORV use areas that were not associated with the pedestrian accessible ramps. Counting visitors at those locations increases the cost and effort beyond the level of resources available for this project.

3.2 SAMPLING DESIGN

Field staff took 19 3-day trips to the Seashore to count at beaches and ramps, for a total of 57 days of counting. Accounting for the logistical difficulties of travel on the islands, clusters of two or three adjacent ORV ramps and nearby beach segments were created. Tables 3-1 and 3-2 list the ramps and beaches in each cluster. Each selected day, field staff traveled to two randomly selected clusters of ramps and beaches. The staff spent 2 hours counting vehicles at each of the two ORV ramps and 2 hours counting beach visitors at the four beach segments in the cluster. In those cases where a cluster consisted of three ramps, two ramps were selected at random for counting. The 57 days of counting resulted in a total sample of 114 clusters covering 228 2-hour ramp-counting opportunities and 456 beach-counting opportunities.

Two strata (categories) based on location were created: (1) Ocracoke Island and (2) Bodie and Hatteras Island. This stratification results in a more cost-effective design since travel to and from Ocracoke is by ferry only. Days were allocated to the two location strata in proportion to the number of ramps on the islands resulting in 18 days to Ocracoke Island and the remaining (39 days) trips to Bodie and Hatteras islands. Two clusters were selected at random from each stratum to visit each day.

Table 3-2. Beach Segments in the Sampling Frame

Beach Segment	Cluster	Beach Segment	Cluster	Beach Segment	Cluster	Beach Segment	Cluster
Ramp 2 A	1	Ramp 27 A	2	Buxton A	4		
Ramp 2 B	1	Ramp 27 B	2	Buxton B	4		
Ramp 2 C	1	Ramp 27 C	2	Buxton C	4	Ramp 55 A	5
Ramp 2 D	1	Ramp 27 D	2	Buxton D	4	Ramp 55 B	5
Rod-Wav-Sal A	2	Ramp 30 A	2	Buxton E	4		
Rod-Wav-Sal B	2	Ramp 30 B	2	Buxton F	4		
Rod-Wav-Sal C	2	Ramp 30 C	2	Buxton G	4		
Rod-Wav-Sal D	2	Ramp 30 D	2	Buxton H	4	Ramp 55 C	5
Rod-Wav-Sal E	2	Ramp 34 A	3	Ramp 43 A	4	Ramp 55 D	5
Rod-Wav-Sal F	2	Ramp 34 B	3	Ramp 43 B	4	Ramp 59 A	6
Rod-Wav-Sal G	2	Ramp 34 C	3	Ramp 43 C	4	Ramp 59 B	6
Rod-Wav-Sal H	2	Ramp 34 D	3	Ramp 43 D	4	Ramp 59 C	6
Rod-Wav-Sal I	2	Avon A	3	Ramp 49 A*	5	Ramp 59 D	6
Rod-Wav-Sal J	2	Avon B	3	Ramp 49 B*	5	Ramp 68 A	7
Rod-Wav-Sal K	2	Avon C	3	Ramp 49 C*	5	Ramp 68 B	7
Rod-Wav-Sal L	2	Avon D	3	Ramp 49 D*	5	Ramp 68 C	7
Rod-Wav-Sal M	2	Avon E	3	Frisco A	5	Ramp 68 D	7
Rod-Wav-Sal N	2	Avon F	3	Frisco B	5	Ocracoke A	7
Rod-Wav-Sal O	2	Avon G	3	Frisco C	5	Ocracoke B	7
Rod-Wav-Sal P	2	Avon H	3	Frisco D	5	Ocracoke C	7
Rod-Wav-Sal Q	2	Avon I	3	Frisco E	5	Ramp 70 A	7
Rod-Wav-Sal R	2	Avon J	3	Hatteras A	5	Ramp 70 B	7
Rod-Wav-Sal S	2	Avon K	3	Hatteras B	5	Ramp 70 C	7
Rod-Wav-Sal T	2	Avon L	3	Hatteras C	5	Ramp 70 D	7
Ramp 23 A	2	Ramp 38 A	3	Hatteras D	5		
Ramp 23 B	2	Ramp 38 B	3	Hatteras E	5		
Ramp 23 C	2	Ramp 38 C	3	Hatteras F	5		
Ramp 23 D	2	Ramp 38 D	3	Hatteras G	5		

Note: The majority of the above beach segments are ¼ mile. The segments in a beach (a lifeguard beach, a village beach, or a ramp beach) are lettered starting with A for the northern-most segment of the beach and moving south.

To determine the time of the day the actual counting would take place, a day was divided into four 4-hour segments: 6 a.m. to 10 a.m., 10 a.m. to 2 p.m., 2 p.m. to 6 p.m., and 6 p.m. to 10 p.m. Two of these four blocks of time were randomly selected for each counting day. Within each 4-hour

segment, 2 hours were spent counting at each of two ramps and 2 hours counting on four beach segments. Whether the ramps were counted in the first or second half of the 4-hour segment was determined randomly.

Three days of the week were designated as trip start days: Tuesday, Friday, and Saturday. Based on personal communication with park staff and the mechanical ramp counter data, it was estimated that counts at ORV ramps were approximately twice as high on weekend days as on weekdays. With 3-day trips starting on Tuesday, Friday, and Saturday, the probability of counting on a particular weekday would be 1/9 and 2/9 for weekend days (each weekday is in the sample one time, while each weekend is in the sample twice). The start date for each trip was selected at random.

To determine how the trips were scheduled across seasons, we assumed a total of 52 weeks per calendar year, each starting on a Tuesday and ending on a Monday, from March 31, 2009, to March 29, 2010. To ensure that we had at least two counting trips taken during the low winter season, we created two seasonal strata out of the 52 weeks. The two seasonal strata roughly correspond to the low and medium/high visitation seasons at the Seashore. Our estimate of the proportion of visitors in the park each week was based on confidential 2007 rental occupancy data by paying guests for houses in the villages on Hatteras Island supplied to RTI by the real estate companies. The lowest visitation stratum, which consists of the 17 weeks from the beginning of December 2009 through the end of March 2010, was assigned two 3-day trips.[3] The remaining 17 trips took place in the 35 weeks that make up the medium and high visitation strata. We allocated the trips across the weeks in each seasonal stratum proportionally to the rental house occupancy in each week.

3.3 PRECISION ESTIMATES FOR SAMPLE DESIGN

The sample size was determined in part using precision estimates. The precision estimates for the ramp-counting sample size were based on data from the infrared counters installed by the park on each ramp. These data are of variable

[3] Without the seasonal strata, only one trip would have been scheduled during the low season based on visitation data.

quality since the infrared counters are affected by external factors that can reduce the accuracy of the count on any specific day. The precision estimates served as a rough guide for the number of counting occasions needed for the surveys to reach a given level of precision.

Using the vehicle counts from the infrared ramp counters, Table 3-3 shows the estimated precision that can be achieved by season and sample size for the vehicle count survey based on the data from the infrared counters. Assuming a total sample size of 220 counting opportunities (220 2-hour counts), the precision estimates suggest that the survey will produce estimates of the number of cars using the ORV ramps during the spring season with a precision of plus or minus 1,280 cars. This value can be interpreted as follows: if we estimate the total number of cars in spring as 20,000 based on the Noncontact Vehicle Counting Survey, then the true and unknown total number of cars using the ramps is between 19,720 and 21,280 with 95% confidence and 80% power.

Table 3-3. Precision (Detectable Difference) by Season and Sample Size

	Sample Size (Counting Occasions)							
Season	**80**	**100**	**120**	**140**	**160**	**180**	**200**	**220**
Spring	2,123	1,899	1,733	1,605	1,501	1,415	1,343	1,280
Summer	5,540	4,955	4,524	4,188	3,918	3,693	3,504	3,341
Fall	2,761	2,469	2,254	2,087	1,952	1,840	1,746	1,665
Winter	101	91	83	77	72	68	64	61

Note: Estimates based on vehicle counts from infrared counters provided by the Seashore staff to RTI.

In general, if preliminary data used in sample size calculations are reliable, the actual precision for a complex sampling design such as the one proposed here involving stratification and clustering will be larger than the precision obtained from a simple random sampling. To estimate the precision, we usually multiply the determined precision in Table 3-3 by a factor known as the design effect (Proctor, 1992; Fields, 1971; and Henry, 1990). The design effect is essentially the ratio of the actual variance, under the sampling method actually used, to the variance computed under the assumption of simple random sampling (as in Table 3-3). The design effect was not estimated because of the uncertainty and high variability in the data used

in sample size estimation; however, it is expected that stratification and clustering and reliable counting techniques will render more precise estimates.

Based on the precision estimates, the counting survey included 228 vehicle counting opportunities. The primary purpose of the survey was to count vehicles, so the precision of the visitor counting estimates was not calculated in advance.

3.4 CAVEATS AND UNCERTAINTIES

The following caveats and uncertainties should be noted:

- The strata are based on input from the Seashore staff and the Negotiated Rulemaking Committee, data from ramp counters, and weekly rental data. The sampling plan reflects a balancing of the data needs for the economic analysis, inputs from different sources, and resource constraints.
- The beach and factors that affect visitation, such as hurricanes, vary year to year, which can affect the sampling plan.
- Resource constraints limited the number of days spent counting and the number of ramps that could be visited in a day.

4 Data Collection

4.1 COUNTING PLANS

The field staff for the Noncontact Vehicle Counting Survey were all RTI International staff. A protocol for counting and recording data was developed and pilot tested. The staff was trained on the protocol and provided with materials. Below we describe in more detail how the counts were conducted.

4.1.1 Vehicle Counting

Two field staff went on each trip. When counting at ramps, the field staff counted simultaneously at two different ramps in the cluster. Field personnel were stationed at the beach ramp on the selected day and time with a data collection sheet. The counting protocol was tested in the fall of 2008 to determine the best place to sit and how to conduct the count and record the data. The data collector was stationed at the entry to the beach ramp for a 2-hour block of time predetermined by the sampling plan. The data collector kept separate counts of vehicles that entered and exited the ramp during the selected time period. The data collector also attempted to capture data about each vehicle, specifically the vehicle type (using classifications provided by NPS, see Appendix A), the number of passengers in each vehicle, the state of the license plate and information about the day, including weather and any special circumstances.

4.1.2 Beach Visitor Counting

Field staff simultaneously counted two sections of beach as determined by the sampling plan. The field staff were given the geo-coordinates of the selected segment of beach. Using a handheld GPS device, they identified the northern and southern or eastern and western boundaries of the selected segment. The data collector walked from one boundary to the other along

the sand dune line. As they walked along the beach, they created an invisible moving line between them and the ocean and counted any person that crossed that invisible line between the data collector and the ocean. The field staff also collected data about the weather and special events at the beach because that may have influenced how many people visit the beach on any given day. Counting individuals who are moving poses challenges. The data collection plan represented what RTI believes is the best approach likely to yield the most accurate count.

5 Results

5.1 RAMP COUNTS

The vehicle counts provide an estimate of the total number of vehicle roundtrips to the beach. They are not directly comparable to the official number of recreational visitors to Cape Hatteras, because these numbers are determined by a traffic counter at Whalebone Junction, combined with the inbound ferry traffic to Ocracoke from the mainland (Cedar Island and Swan Quarter ferries). A single recreational visit, as counted by the Whalebone Junction counter or mainland-to-Ocracoke ferry traffic count, can include multiple vehicle roundtrips over an ORV ramp to the beach.

The data from the counting trips were weighted based on the sampling design and the probability that a ramp was selected for counting at a certain time or a certain day. Based on the data from the ramp counts, the mean estimate is 499,802 vehicle roundtrips over an ocean-side ramp onto the Seashore beaches between April 2009 and March 2010, with a 95% confidence interval of 276,946 to 722,659. An estimated mean of 994,604 passengers were inside these vehicles with a 95% confidence interval of 654,961 to 1,334,247 passengers (Table 5-1). As with the number of vehicle roundtrips, the estimated number of passengers is not directly comparable to the official statistics on recreational visitors to the Seashore. A visitor using the ramps could make several roundtrips over the ramps in a day and would result in counting the same visitor multiple times.

Table 5-1. Estimates and 95% Confidence Intervals for Number of Vehicles Making a Roundtrip to the Beach over an Oceanside Ramp and Associated Passengers by Time Strata[a]

	Vehicle Roundtrips			Passengers		
		95% Confidence Interval			95% Confidence Interval	
Time Interval	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
April 2009 to November 2009	344,999	284,696	405,302	768,948	625,928	911,968
December 2009 to March 2010	154,803	0	392,594	225,656	0	567,185
52 week total	499,802	276,946	722,659	994,604	654,961	1,334,247

[a]These vehicle access counts provide an estimate of the total number of vehicle roundtrips to the beach. Currently the NPS method for compiling visitation only uses the Whalebone Junction counts, combined with the inbound ferry traffic count to Ocracoke Island from the mainland (Cedar Island and Swan Quarter ferries), because a vehicle using the ramps could make several roundtrips in a day and would result in counting the same visitor multiple times.

As seen in Table 5-1, the increased sampling coverage between April and November resulted in narrower confidence intervals around the April and November estimates. Between April and November, the 95% confidence interval is +/−17% of our point estimate of 344,999 vehicle roundtrips. Between December and March, the 95% confidence interval is +/−151%.

Table 5-2 reports the average daily vehicle roundtrips and associated passengers by ramp for the period of April to November 2009. The most popular ORV ramp between April and November was ramp 4 on Bodie Island; however, ramps 43, 49, 55, and 70 were all estimated to average over 100 vehicle roundtrips a day between April and November 2009. An estimated 59% of vehicle roundtrips took place on the various ramps through Hatteras Island, 26% on Ocracoke Island, and 15% on Bodie Island. Confidence intervals for the vehicle roundtrip estimates range from +/−18% for ramp 70 to +/−132% for ramp 44. Similar estimates of the geographic distribution of ORV use between December and March could not be estimated because of the lack of sampling coverage. April through November captures the majority of vehicle roundtrips that would be affected by the proposed management alternatives, however.

Table 5-2. Estimates and 95% Confidence Intervals for Daily Vehicle Roundtrips and Associated Passengers by ORV ramp (April to November 2009)[a]

	Vehicle Roundtrips			Associated Passengers		
Ramp		95% Confidence Interval			95% Confidence Interval	
	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
2	40	27	54	66	41	92
4	173	95	251	409	196	622
23	55	0	111	105	0	213
27	58	17	98	142	21	263
30	54	16	92	138	32	245
34	60	25	96	124	49	198
38	82	45	119	178	90	266
43	134	53	215	273	78	468
44	87	0	200	230	0	547
49	134	9	260	349	11	688
55	152	58	246	326	90	562
59	66	38	95	153	75	231
67	48	20	76	100	37	162
68	14	2	26	26	0	51
70	156	128	183	318	227	410
72	76	15	138	167	29	306

[a]These vehicle access counts provide an estimate of the average daily number of vehicle roundtrips to the beach. Currently the NPS method for compiling visitation only uses the Whalebone Junction counts, combined with the inbound ferry traffic count to Ocracoke Island from the mainland (Cedar Island and Swan Quarter ferries), because a vehicle using the ramps could make several roundtrips in a day and would result in counting the same visitor multiple times.

5.2 BEACH COUNTS

As described in Section 3.3, we counted individuals on the beach on 103 pedestrian-accessible beach segments, totaling 25.6 miles of beach. Since this counting method is at a single point in time, we express the results in total visitor-hours.[4] From Table 5-3, we estimate that visitors spent 5.4 million hours on the 25.6 miles of the Seashore beach included in the sample, with 5.2 million hours spent between April and November. The 95% confidence interval around the estimate

[4] The estimates of visitor-hours are not directly comparable to the ORV counts. An estimate of the average time spent by visitors would be needed to convert visitor-hours to visitors.

Table 5-3. Estimates of Visitor Hours and 95% Confidence Intervals for Time Strata

Time Interval	Estimate of Total Hours	95% Confidence Interval	
		Lower Bound	Upper Bound
April 2009 to November 2009	5,214,557	2,567,214	7,861,900
December 2009 to March 2010	158,124	0	396,808
52-week total	5,372,681	2,721,259	8,024,104

from April to November is +/−51%, while from December to March it is +/−151%. The 95% confidence interval for the entire sample is +/−49%.

For April through November, we estimate that 42% of these visitor hours were on the beaches surrounding Rodanthe, Salvo, and Waves and on the beaches within 0.5 miles of Ramps 23, 27, and 30, while 24% were on beaches surrounding Buxton and Ramp 43. The 95% confidence intervals around these estimates varied from +/−47% to +/−99%. Because of low sampling between December and March, we are not able to produce reliable results by geographic area.

Looking at average daily visitor hours per mile in Table 2-4, three areas had much higher use: Coquina Beach; the beaches surrounding Rodanthe, Salvo, and Waves and on the beaches within 0.5 miles of Ramps 23, 27, and 30; and the beaches surrounding Buxton and Ramp 43. These beaches also had the highest average daily crowding. The average daily visitors per mile, in the last 3 columns of Table 5-4, can be interpreted as a measure of average crowding across the day, although we would need the average numbers of hours visitors spend on the beach to convert the visitor hours to unique visitors. The least crowded beaches were the beaches from Ocracoke included in the sample, including the lifeguarded beach on Ocracoke and the beaches 0.5 miles from ramps 68 and 70.

Table 5-4. Estimates of Visitor Hours and 95% Confidence Intervals for Clusters of Ramps (April to November 2009)

		Average Daily Visitor Hours			Average Daily Visitor Hours per Mile		
			95% Confidence Interval			95% Confidence Interval	
Area	**Length (miles)**	**Estimate**	**Lower Bound**	**Upper Bound**	**Estimate**	**Lower Bound**	**Upper Bound**
Coquina Beach	1.1	1,007	122	1,893	916	111	1,721
Rodanthe, Salvo, and Waves, Ramps 23, 27 & 30	7.8	8,891	814	16,967	1,140	104	2,175
Avon, Ramps 34 and 38	5.3	3,070	1,636	4,504	579	309	850
Buxton, Ramp 43	3.1	5,174	860	9,488	1,669	277	3,061
Frisco and Hatteras, Ramps 49 and 55	4.6	1,674	12	3,336	364	3	725
Ramp 59	1	416	71	760	416	71	760
Ocracoke, Ramps 68 and 70	2.7	934	329	1,540	346	122	570

We cannot directly compare the number of passengers in ORVs in Table 5-2 to the number of visitor hours on a stretch of beach in Table 5-4. From Table 5-2, ramps 4, 43, 49, 55 and 70 had the most vehicle round trips between April and November. The beach 0.5 miles above and below Ramps 4 and 49 were not included in the visitor count because the ramps do not provide easy pedestrian access to the beach. Looking at the ramps that were included in the beach counting, Ramp 43 appears to be the only ramp that is one of the most heavily used by vehicles and is part of a stretch of beach that has the highest average daily visitor hours per mile.

6 References

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Appendix A: Vehicle Classifications

Vehicle Type	Description	Examples
LDV	Passenger cars (sedans, coupes, compacts, convertibles, etc., small & large). Also includes minivans.	**Passenger:** Honda Accord; Toyota Corolla; Ford Focus; Chevy Malibu; **Minivans:** Honda Odyssey; Toyota Sienna; Nissan Queso; Dodge Caravan;
LDT1, LDT2	Small & medium SUVs, pickup trucks, & also passenger & commercial vans	**SUVs:** Chevy Trailblazer; Ford Explorer; Jeep Grand Cherokee; Toyota Highlander, RAV4; Nissan Pathfinder; **Pickup Trucks:** Chevy Colorado; Toyota Tacoma; Nissan Frontier; Ford Ranger
LDT3, LDT4	Large SUVs & pickups	**SUVs:** Ford Expedition; Chevy Tahoe, Suburban; GMC Yukon; Nissan Armada; Toyota Sequoia **Pickup Trucks:** Chevy Silverado; GMC Sierra; Ford F-150; Dodge Ram; Nissan Titan; Toyota Tundra
HDV2B	Large pickups (likely diesels)	Ford F-250, 350 pickups; Dodge Rams medium and heavy-duty