ASSESSMENT OF OCEAN BEACH VEHICULAR USE at FORT FISHER STATE RECREATION AREA KURE BEACH, NC

A study funded by the N.C. General Assembly
and performed by faculty of
The University of North Carolina at Wilmington
for the
N.C. Department of Environment and Natural Resources

NCDENR
North Carolina Department of Environment and Natural Resources

NORTH CAROLINA STATE PARKS
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Access Gate for Beach Vehicles

Executive Summary

In response to ongoing public concerns, the FY 2005 North Carolina budget bill directed approximately $25,000 to fund a study of vehicular beach use and associated effects at the Fort Fisher State Recreation Area (FOFI) located near Kure Beach, NC. Faculty members at the University of North Carolina at Wilmington were contracted by the N.C. Department of Environment and Natural Resources (DENR) to investigate the demand for vehicle access to the FOFI beach, biological impacts of ocean beach vehicular use and the potential economic impact restricting vehicle access. The three studies were conducted between August 15, 2004, and December 15, 2004, with submission of a draft report to DENR/Division of Parks and Recreation (DPR) by December 31, 2004. Public input was received at a public meeting held on October 11, 2004, in Wilmington and through written comments submitted directly to DPR.

Results of the **vehicle access demand** study (see pp. 3-23) by Drs. James Herstine, Jeffery Hill and Robert Buerger found that among surveyed users and vehicles counted at the access gate, the majority of ocean beach vehicular use at FOFI involved one or two persons per vehicle and occurred during the daytime:

"…During the September - February time period, 73% of the users were exclusively daytime users, and during the March - August time period, the figure increases to 79%. This finding indicates that nighttime use of the ocean beach at FOFI is not significant. This is confirmed by the four-wheel drive vehicular access counts which indicate that 75% of the users entered during the daytime hours. Therefore, limiting ocean beach vehicular access to FOFI during the nighttime hours would impact a relatively small percentage of users."

Also, spot surveys indicated that nighttime use during the March - August period involved more driving along the beach strand, as opposed to staying in one location – a type of use that could negatively impact ocean beach-dependent species such as nesting sea turtles and water birds. Because of the limited study period, the authors recommended that a final management decision should be made only after a longer (i.e., two-year) investigation to obtain seasonally accurate data beyond the three-month scope of this study.

Biological impacts of vehicles on protected species were assessed by Dr. Wm. David Webster (see pp. 24-48). He found that FOFI is home to 10 species of federal or state significance. The site is used throughout the year by one or more of these listed species, but most of the species are present during the spring through fall months. Off-road-vehicle (ORV) lights and tire ruts negatively affect nesting/hatchling sea turtles. Young seabeach amaranth plants are destroyed by traffic and unable to set seed. ORV traffic in the beachfront and in marsh intertidal areas compacts soil, making it unsuitable for worms and other invertebrates used as forage by shorebirds.

One of Dr. Webster's key recommendations was that State management policies affecting listed species should be based on the same dates used by state and federal natural resource agencies (such as U.S. Fish and Wildlife Service). Dr. Webster concluded that there is no benefit in closing FOFI to ORV traffic for three nights around the full moon, since sea turtles nest approximately every two weeks independent of the lunar cycle. Dr. Webster also recommended that the State: 1. either: a.) suspend all ORV traffic during April 1 through November 15 --or-- b.) permanently prohibit all ORV traffic from the southernmost two miles of FOFI; 2. Institute weekly shorebird and colonial waterbird surveys for three years and 3. Assess the ORV policy at the end of that three-year period to determine if ORV restrictions have had a positive effect on protected species and revise use policies accordingly.

Dr. Chris Dumas prepared an **economic impact analysis** (see pp. 49-71) of three different approaches to managing vehicle access to the beach in Fort Fisher State Recreation Area:

1. 24-hour vehicle access to the beach year round
2. daytime vehicle access only; and
3. complete prohibition of ocean beach driving.

An addendum (pp. 72-78) estimates the impacts of the current park policy of allowing 24-hour vehicle access to the beach from September 15-March 15, but prohibiting nighttime ORV access during the remainder of the year.

Dr. Dumas used input-output analysis, which estimates both the initial, direct economic impact of each vehicle access policy and the indirect or ripple effect on supplying businesses and household spending, in performing the economic analysis. The economic impact analysis was based on the vehicular counts and spot surveys conducted as part of the vehicle access demand study. As a result, it similarly relies on a small sample of beach users.

Based on the information available from the vehicle access demand study, year-round unrestricted vehicle access results in 28,884 trips per year onto the FOFI four-wheel drive access area. Information provided by 120 surveyed beach users suggests mean direct expenditures of $388.56 per trip, for a total direct contribution of $ 11,223,168 to the local economy. Dr. Dumas' model predicted that those direct contributions could have a total economic impact (including the modeled indirect impacts) of $21.6 million in annual regional sales, 382 regional jobs and $3.74 million in combined tax revenues. These figures became the baseline for comparison of alternative vehicle access policies.

A complete prohibition of ocean beach driving in the park would have the greatest negative economic impact, reducing the direct and indirect benefits to the regional economy by approximately 50%. Dr. Dumas estimated the current park policy (allowing 24-hour vehicle access for six months and allowing daytime only access in the spring and summer months) to reduce the direct and indirect benefits to the

regional economy by approximately 4%. Under the current policy, the economic analysis predicts that vehicle access to FOFI would support $20.7 million in annual regional sales, 367 regional jobs and $3.55 million in combined tax revenue.

The vehicle access demand study indicated that a large percentage of visitors using the four-wheel drive access area at night are local residents. Local users accounted for 86% of evening trips to FOFI during the summer months and 71% of evening trips in the fall and winter. Local users would not be expected to spend as much money to visit the beach at FOFI per trip as a visitor from outside the county who would have additional travel and lodging expenses. On the other hand, the impacts of visitors from outside the county who visit only in the spring/summer season may not be fully captured by the analysis. Dr. Dumas noted that a more detailed analysis of the current management policy would require survey vehicle survey data from the spring and summer months.

Ocean Beach at First Public Dune Crossover (1/8/05)

DENR Recommendation

The Department of Environment and Natural Resources (DENR) finds that the UNCW study provides the best assessment of vehicle access demand, biological impacts and economic impacts possible within the timeline authorized by the General Assembly. Although additional research could be helpful, general trends described in the report are not likely to change: 1.) beach driving, particularly at night, poses a serious threat to rare species at FOFI year round; 2.) the threat is most significant in spring and summer months when the greatest number of species are nesting; 3.) nighttime beach use represents a relatively small percentage of overall vehicular use and 4.) most nighttime beach users are local residents. The study suggests that a year round prohibition of beach driving could have a significant economic impact, but restricting nighttime driving only during spring and summer months is projected to have a very minor economic impact.

Since the study demonstrates that rare species at FOFI would benefit most from a restriction on nighttime driving in the spring and summer months and that restricting only nighttime driving during those months would not have a significant impact on the local economy, DENR concludes that the current management policy of restricting nighttime driving from March 15 - September 15 should continue. Although completely prohibiting beach driving within FOFI would provide more protection to rare species, the economic impacts would be out of proportion to the additional natural resource benefits.

Introduction

Ocean beach vehicular access has been a controversy at Fort Fisher State Recreation Area (FOFI) for a number of years. Concerns have been voiced by local fisherman and residents who wish to have access to the site at all times. However, other users and state park staff feel that protection of federal/state listed species (e.g., nesting loggerhead sea turtles and water birds) from vehicular impacts on the oceanfront plus staffing limitations during March through September should require a schedule typical of state park properties. To provide focused information on this matter, the North Carolina General Assembly included the following language in the FY 2005 budget bill:

TWENTY-FOUR-HOUR ACCESS TO FORT FISHER STATE RECREATION AREA DURING THE FALL AND WINTER/ FUNDS FOR DEPARTMENT STUDY/ACTIVITIES AT FORT FISHER

SECTION 12.3.(a) G.S. 113 – 35 is amended by adding a new subsection to read: "(b1) Members of the public who pay a fee under subsection (b) of this section for access to Fort Fisher State Recreation Area may have 24-hour access to Fort Fisher State Recreation Area from September 15 through March 15 of each year."

SECTION 12.3.(b) The Department of Environment and Natural Resources shall conduct a study of vehicle use at Fort Fisher State Recreation Area. In preparing the study, the Department shall consult with experts in the fields pertinent to this study at the University of North Carolina at Wilmington. This study shall consider and determine in its findings the demand for vehicle access to the beach at Fort Fisher State Recreation Area during different times of the year. This study also shall include a review of scientific studies on the impact of vehicle use on sea turtles and nesting seabirds and shorebirds. This study shall provide an opportunity for comment from interested citizens. This study shall include in its report its finding on sea turtle and bird nesting activity at Fort Fisher State Recreation Area as compared with nesting activity on the adjoining beach that is managed by Bald Head Conservancy and on Masonboro Island and an analysis of the economic impact of restricting 24-hour vehicle access to the beach at Fort Fisher State Recreation Area. No later than February 1, 2005, the Department shall report its findings under this subsection, any other pertinent findings, and any recommendations or legislative proposals to the Environmental Review Commission.

SECTION 12.3.(c) Of the funds appropriated to the Department of Environment and Natural Resources for the 2004 – 2005 fiscal year, the sum of twenty-five thousand dollars ($25,000) shall be used for the costs to the Department of conducting the study under subsection (b) of this section and for education, conservation, and enforcement activities by the Department at Fort Fisher State Recreation Area.

(House Bill 1414-Ratified)

As mentioned in the above bill, expertise to perform these studies was available at the University of North Carolina at Wilmington (UNCW). In August 2004 the N.C. Department of Environment and Natural Resources (DENR) contracted selected researchers to investigate the specified tasks of access demand, biological impacts of vehicles and economic impacts of access restriction.

Faculty in the university departments of Health and Applied Human Sciences/Environmental Studies (Drs. Robert Buerger, James Herstine and Jeffrey Hill), Biology (Dr. Wm. David Webster) and Economics and Finance (Dr. Chris Dumas) were chosen to perform the work. Drs. Buerger, Herstine and Hill have completed human dimension studies (e.g., principle investigators on a long-term study of visitor use impacts on nearby Masonboro Island and Zeke's Island, both managed by the DENR/Division of Coastal Management) plus Dr. Herstine is a member of the Fort Fisher Park Advisory Committee. Dr. Webster has performed multi-year studies of nesting sea turtles at Masonboro Island and the Bald Head Island complex and assisted with monitoring of local nesting water bird populations. Dr. Dumas has completed various economic impact studies relating to environmental issues.

Contracts between DENR and UNCW were developed for each of the three study areas. Work was performed during August 15 through December 15, 2004, with final reports submitted to DENR/Division of Parks and Recreation (DPR) on December 31.

A public forum was held on October 11, 2004, at the UNCW Center for Marine Science in Wilmington to receive verbal and written comments on all ocean beach vehicular access-related issues. DENR/DPR staff and contracted faculty discussed the proposed research with the audience. UNCW investigators took notes on verbal public input that evening. All letters received by the DPR following the meeting were forwarded to university researchers.

I. FOFI Vehicular Access Demand

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Abstract

The ocean beach vehicular access study at Fort Fisher State Recreation Area (FOFI) was conducted between August 15, 2004, and December 15, 2004. A total of 10,545 vehicles entered FOFI during this period. Of the total, 5,555 would be considered daytime users (entered the area between sun-up and sun-down) and 1,841 nighttime users (entered the area between sun-down and sun-up). Three thousand one hundred and forty-nine (3,149) vehicles entered FOFI between August 15th and September 14th, but were not differentiated as daytime and nighttime users by the photoelectric cell system in place during this period. No counts were made between September 15th and September 23rd due to a malfunctioning of the electronic counting system.

A total of 181 spot surveys were administered to vehicles entering FOFI between September 15th and December 15th. Of these, 127 were valid surveys, for a response rate of over 71%.

Background

This document has been prepared in partial fulfillment of a contract to the University of North Carolina Wilmington (UNCW) for an Ocean Beach Vehicular Access Study at FOFI located near Kure Beach, North Carolina (see **Appendix A—Map of Fort Fisher State Recreation Area**). This study was authorized under the 2004 North Carolina House Bill 1414, Section 12.3(b).

Scope of Work

Demand Analysis: Drs. Robert Buerger, Jim Herstine and Jeffery Hill will determine from available past and present data the demand for ocean beach vehicular access throughout the year with emphasis on assessing nighttime use. This will be derived from vehicular counts taken at FOFI plus spot surveys performed to determine the geographic distribution of users and likely frequency of use.

Deliverables

The deliverables consist of a summary report that encompasses a record of the number of vehicles utilizing FOFI during the study period, any relevant prior data and results of spot surveys of users.

Methodology

The methodology for this study consisted of two (2) components: 1) electronic counts of vehicles entering FOFI (**Appendix B—Four-Wheel Drive Vehicle Access Count**); and, 2) spot surveys administered to individuals in vehicles entering FOFI (**Appendix C—Ocean Beach Vehicular Access Survey**).

Electronic counts: The electronic counts of vehicles entering FOFI were taken by FOFI staff using two different methodologies. Initially, the counts were taken utilizing a photoelectric cell system which registered whenever the beam between the units was interrupted. This system was utilized from July 2nd through October 31st. However, no electronic counts are available between September 15th and September 23rd due to a malfunction of the photoelectric cell system. A gate system with an access keypad was installed and utilized to record the number of vehicles entering FOFI from November 1st through December 15th.

Spot surveys: A survey instrument was developed in conjunction with the economist contracted for this project (**Appendix C—Ocean Beach Vehicular Access Survey**). Once the instrument was finalized, a training session was held with the 10 survey administrators. The spot surveys were administered on twenty-seven (27) different dates at varied times and days between September 15th and December 15th (**Appendix D—Survey Schedule**). Dates and times were selected using purposive sampling in order to gain representative data from users throughout the weekdays and weekends, as well as to ensure that data were gathered from time periods throughout both the daytime and nighttime. Survey administrators were located at the entrance to the four-wheel drive access trail. They were specifically instructed to approach and stop all vehicles entering or exiting the four-wheel drive access trail, identify themselves, and ask whether the users would be willing to participate in a voluntary survey of ocean beach vehicular access to FOFI. If the user refused or had

previously participated, the survey administrator was instructed to note this on the survey form, thank them and terminate the interview. If the user provided any justification for not participating in the survey, this was recorded. Additionally, if the survey administrator was able to determine the number of users in the vehicle, this was recorded as well. If the user agreed, the survey was administered.

Electronic Count Results

Frequency of Visitation by Time of Day

Electronic counts (**Appendix B—Four-Wheel Drive Vehicle Access Count**) were intended to provide data regarding total daily visitation as well as differentiation of visitation by time of day. During the July 2nd through December 15th time period, 15,883 vehicles were recorded passing through the FOFI ocean beach vehicular access entrance. As anticipated, total visitation declined during this period, with the exception of the month of October when the surf fishing tournament was held (**Table 1—Monthly FOFI Four-Wheel Drive Vehicle Access Count**).

Month	Count	Percentage	Mitigating Factors
July	3,848	24%	
August	3,390	21%	Closed August 14th for Hurricane Charlie
September	2,347	15%	Counter malfunction September 15th-23rd
October	4,850	31%	Surf fishing tournament October 1st-3rd
November	1,280	8%	
December	168	1%	Counts ended December 15th
Total	15,883	100%	

Table 1—Monthly FOFI Four-Wheel Drive Vehicle Access Count

After September 23rd, a differentiation was made between daytime and nighttime vehicular entrance into the FOFI ocean beach. The results indicate that the majority of vehicles (75%) entered during the daytime hours (**Table 2—Four-Wheel Drive Vehicle Access Count Differentiating Between Daytime and Nighttime Entrance**).

Month	Daytime Count	Daytime Percentage	Nighttime Count	Nighttime Percentage
September	855	79%	231	21%
October	3,552	73%	1,298	27%
November	992	78%	288	22%
December	156	93%	12	7%
Total	5,555	75%	1,829	25%

Table 2—Monthly FOFI Four-Wheel Drive Vehicle Access Count Differentiating Between Daytime and Nighttime Usage

Spot Survey Results

The FOFI Ocean Beach Vehicular Access Survey contained eight questions (**Appendix C—Ocean Beach Vehicular Access Survey**). Of these, Question 1 was a qualifying question to determine whether the respondent was of majority age. Only those individuals of majority age were asked to complete the survey. Questions 2, 3 and 4 focused upon the demand for ocean beach vehicular access throughout the year. As such, the data from these questions comprise the results of the ocean beach vehicular access demand component of the study. The remaining questions focus upon deriving data for an economic impact analysis of restricting 24-hour access to the ocean beach at FOFI. The analysis of these questions will be completed by an economist specifically addressing the resultant data.

Number of Users Per Vehicle

The number of individuals in the surveyed vehicles driving on the FOFI ocean beach ranged from 1 to 5, with the majority of vehicles (78%) containing either 1 or 2 individuals (**Figure 1—Number of People per Vehicle in Surveyed Vehicles Driving on the FOFI Ocean Beach**).

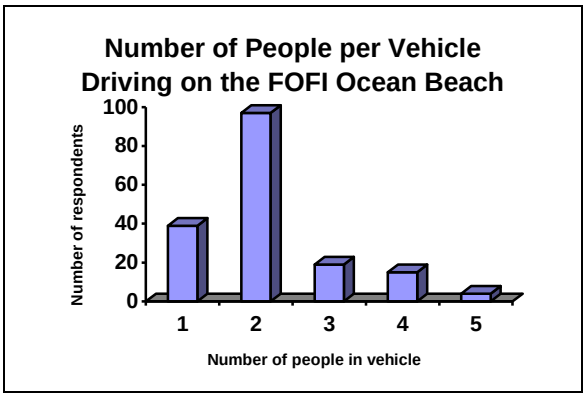


Figure 1—Number of People per Vehicle in Surveyed Vehicles Driving on the FOFI Ocean Beach

Distribution of Visitation by Season

Results of the analysis of demand data indicate that 90 of the 127 respondents (71%) drove on the FOFI ocean beach during the months of March—August during the previous 12 months. Conversely, 37 of the 127 respondents (29%) reported that they had never driven their vehicle on the ocean beach at FOFI during the months of March—August during the previous 12 months (**Figure 2—Percentage of Respondents Who Indicated They Drove Their Vehicle on the Ocean Beach at FOFI Between March and August**).

On the other hand, 120 of the 127 respondents (94%) drove on the FOFI ocean beach during the months of September—February during the previous 12 months. Only 7 of the 127 respondents (6%) reported that they had never driven their vehicle on the ocean beach at FOFI during the months of September—February during the previous 12 months (**Figure 3—Percentages of Respondents Who Indicated They Drove Their Vehicle on the Ocean Beach at FOFI Between September and February**).

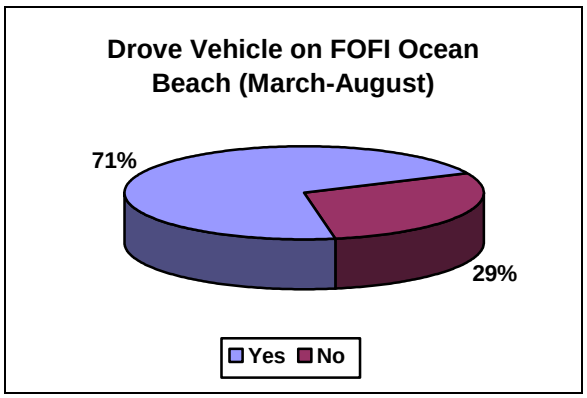


Figure 2—Percentages of Respondents Who Indicated They Drove Their Vehicle on the Ocean Beach at FOFI Between March and August

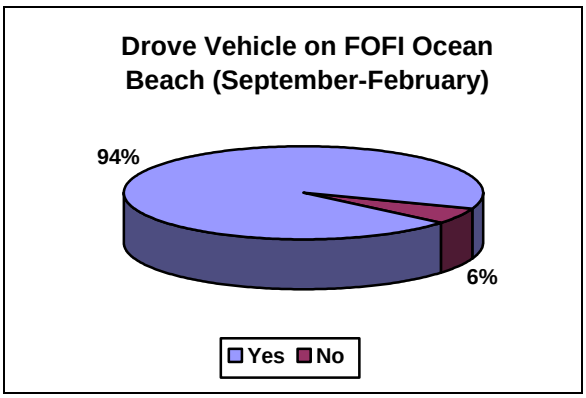


Figure 3—Percentages of Respondents Who Indicated They Drove Their Vehicle on the Ocean Beach at FOFI Between September and February

Frequency of Visitation by Season

Forty-one (41) of the 127 respondents (32%) reported that they drove their vehicle on the ocean beach at FOFI during March—August between 1 and 10 times during the previous 12 months. The majority of such users, 67 of the 127 respondents (53%), indicated that they drove their vehicle on the ocean beach at FOFI during March—August between 1 and 30 times during the previous 12 months (**Figure 4—Number of Times During the Previous 12 Months Respondents Drove Their Vehicle on the Ocean Beach at FOFI Between March and August**).

However, 68 of the 127 respondents (54%) reported that they drove their vehicle on the ocean beach at FOFI during September—February between 1 and 10 times during the previous 12 months, which comprise the majority of respondents (**Figure 5—Number of Times During the Previous 12 Months Respondents Drove Their Vehicle on the Ocean Beach at FOFI Between September and February**).

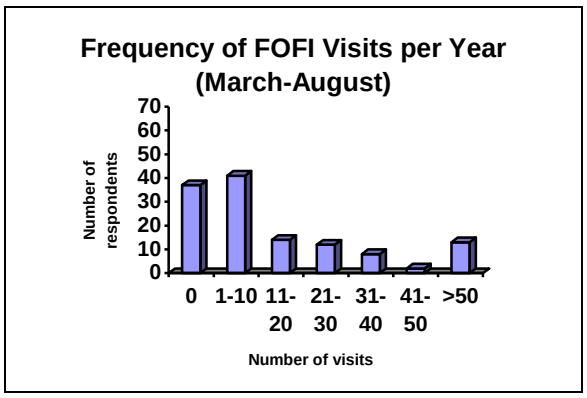


Figure 4—Number of Times During the Previous 12 Months Respondents Drove Their Vehicle on the Ocean Beach at FOFI Between March and August

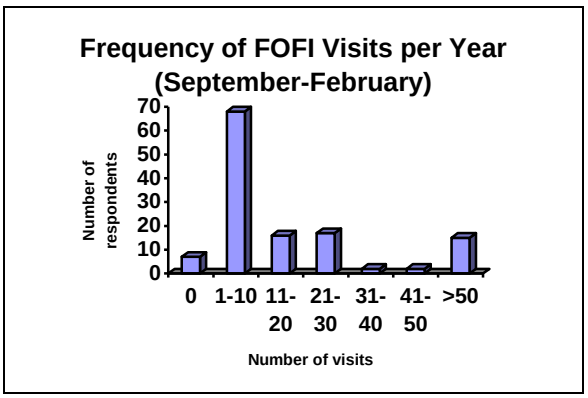


Figure 5—Number of Times During the Previous 12 Months Respondents Drove Their Vehicle on the Ocean Beach at FOFI Between September and February

Frequency of Visitation by Time of Day

Of the 127 respondents, only 27 (21%) included some nighttime driving on the ocean beach during the months of March—August during the previous 12 months. Only 17 of the 127 respondents (13%) indicated that some of their trips were exclusively nighttime driving during the months of March—August during the previous 12 months (**Figure 6—Percentages of Respondents Who Indicated They Drove Their Vehicle at Night on the Ocean Beach at FOFI Between March and August**).
However, 36 of the 127 respondents (27%) included some nighttime driving on the ocean beach during the months of September—February during the previous 12 months. Only 29 of the 127 respondents (23%) indicated that their trips were exclusively nighttime driving during the months of September—February during the previous 12 months (**Figure 7—Percentages of Respondents Who Indicated They Drove Their Vehicle at Night on the Ocean Beach at FOFI Between September and February**).

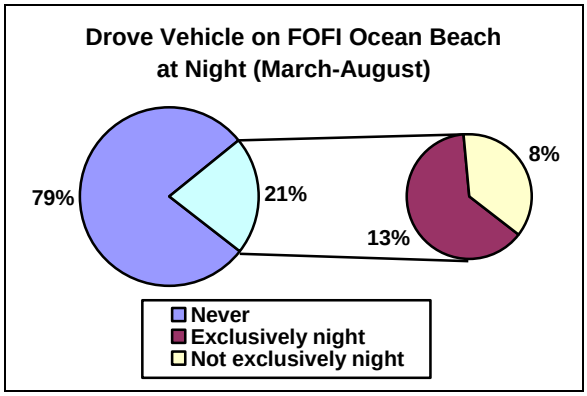


Figure 6—Percentages of Respondents Who Indicated They Drove Their Vehicle at Night on the Ocean Beach at FOFI Between March and August

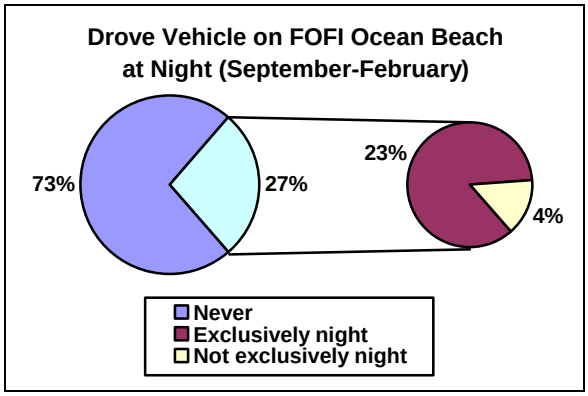


Figure 7—Percentages of Respondents Who Indicated They Drove Their Vehicle at Night on the Ocean Beach at FOFI Between September and February

In all instances, not only did nighttime driving on the ocean beach at FOFI comprise a marginal amount of overall use, but the number of nighttime driving trips was limited as well. Only 20 of the 127 total respondents (16%) reported that they drove their vehicle at nighttime on the ocean beach at FOFI during March—August between 1 and 10 times during the previous 12 months. Nonetheless, this proved to be the majority of that group who drove their vehicle at nighttime on the ocean beach at FOFI during March—August during the previous 12 months (74%) (**Figure 8—Number of Times During the Previous 12 Months Respondents Drove Their Vehicle at Night on the Ocean Beach at FOFI Between March and August**).

Only 17 of the 127 total respondents (16%) reported that they drove their vehicle at nighttime on the ocean beach at FOFI during September—February between 1 and 10 times during the previous 12 months. The majority of those users who drove their vehicle at nighttime on the ocean beach at FOFI during September—February during the previous 12 months, 25 of the 36 respondents (69%), indicated that they did so between 1 and 20 times during this period (**Figure 9—Number of Times During the Previous 12 Months Respondents Drove Their Vehicle at Night on the Ocean Beach at FOFI Between September and February**).

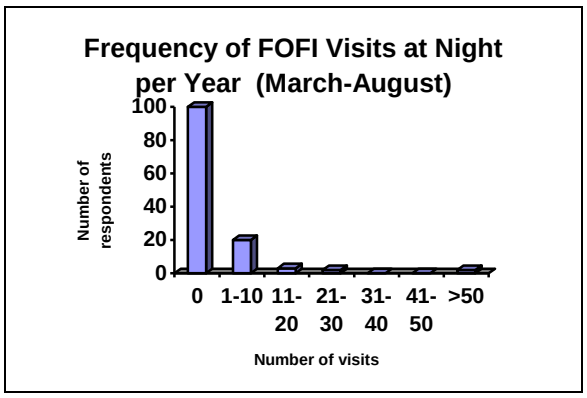


Figure 8—Number of Times During the Previous 12 Months Respondents Drove Their Vehicle at Night on the Ocean Beach at FOFI Between March and August

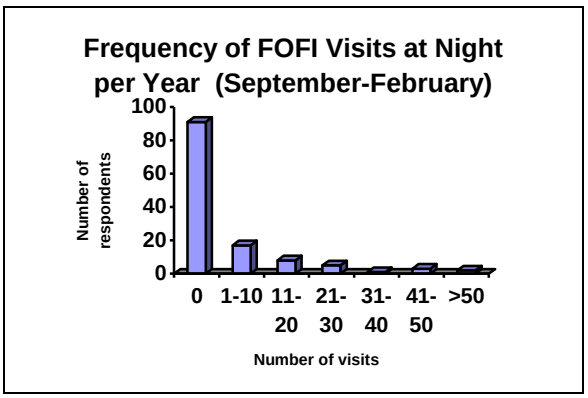


Figure 9—Number of Times During the Previous 12 Months Respondents Drove Their Vehicle at Night on the Ocean Beach at FOFI Between September and February

Physical Distribution of Visitation

Eighty-three (83) of the 128 respondents (65%) indicated that they do not normally drive their vehicle to a specific spot on the beach, stop and remain in that location for the duration of their visit. The remaining 45 respondents (35%) indicated that they normally do drive their vehicle to a specific spot on the beach, stop and remain in that location for the duration of their visit (**Figure 10—Percentages of Respondents Who Indicated They Drove Their Vehicle to a Specific Spot on the Ocean Beach at FOFI, Stopped and Remained in that Location for the Duration of Their Visit**). However, those locations where individuals drive their vehicle to a specific spot on the beach, stop and remain in that location for the duration of their

visit are minimally clustered, yet widely dispersed along the ocean beach at FOFI (**Appendix E—Distribution of Stationary FOFI Ocean Beach Vehicular Users**).

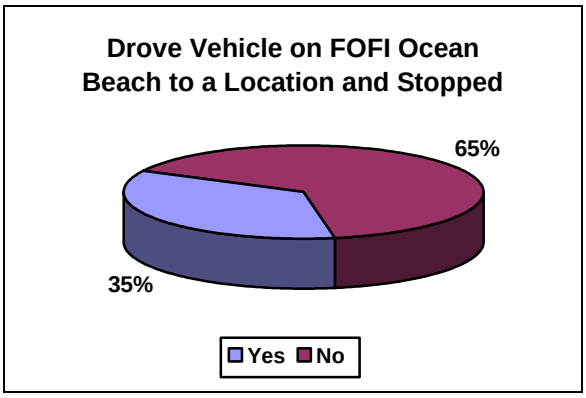


Figure 10—Percentages of Respondents Who Indicated They Drove Their Vehicle to a Specific Spot on the Ocean Beach at FOFI, Stopped and Remained in that Location for the Duration of Their Visit

Those indicating driving on the FOFI ocean beach reported minor differences in their intent to drive their vehicle to a specific spot on the beach, stop and remain in that location for the duration of their visit between the March—August (**Figure 11—Percentages of Respondents Who Indicated They Drove Their Vehicle to a Specific Spot on the Ocean Beach at FOFI, Stopped and Remained in that Location for the Duration of Their Visit Between March and August**) and September—February (**Figure 12—Percentages of Respondents Who Indicated They Drove Their Vehicle to a Specific Spot on the Ocean Beach at FOFI, Stopped and Remained in that Location for the Duration of Their Visit Between September and February**) time periods. Those driving on the FOFI ocean beach in the September—February time period were slightly more inclined not to remain stationary, and in both cases, this group was the majority (57% and 64% respectively).

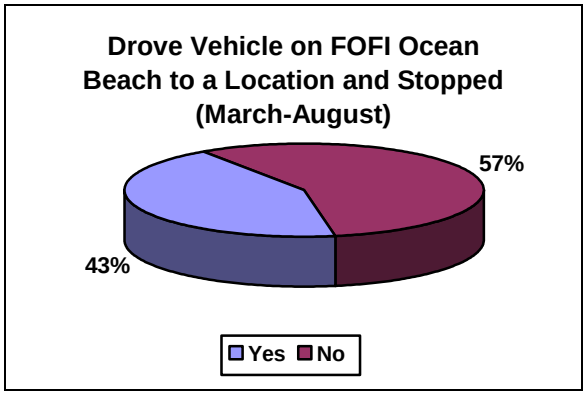


Figure 11—Percentages of Respondents Who Indicated They Drove Their Vehicle to a Specific Spot on the Ocean Beach at FOFI, Stopped and Remained in that Location for the Duration of Their Visit Between March and August

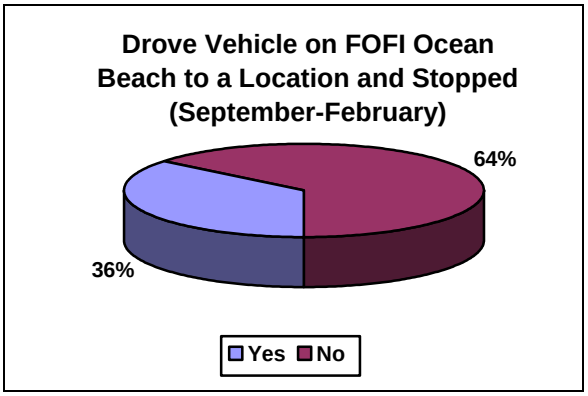


Figure 12—Percentages of Respondents Who Indicated They Drove Their Vehicle to a Specific Spot on the Ocean Beach at FOFI, Stopped and Remained in that Location for the Duration of Their Visit Between September and February

However, even though those users who indicated driving at nighttime on the FOFI ocean beach were a minority, these groups did report differences in their intent to drive their vehicle to a specific spot on the beach, stop and remain in that location for the duration of their visit between the March—August (**Figure 13—Percentages of Respondents Who Indicated They Drove Their Vehicle at Night to a Specific Spot on the Ocean Beach at FOFI, Stopped and Remained in that Location for the Duration of Their Visit Between March and August**) and September—February (**Figure 14—Percentages of Respondents Who Indicated They Drove Their Vehicle at Night to a Specific Spot on the Ocean Beach at FOFI, Stopped and Remained in that Location for the Duration of Their Visit Between September and February**) time periods. Those driving at nighttime on the FOFI ocean beach in the March—August time period were significantly more inclined not to remain stationary (70%) than those in the September—February time period (47%), and more consistent with the respondent pool as a whole (65%). In conflict with the overall respondent trend, those individuals who reported driving at nighttime on the ocean beach at FOFI during the September—February time period were significantly more inclined to drive their vehicle to a specific spot on the beach, stop and remain in that location for the duration of their visit (53%) than either those in the March—August time period (30%) or the respondent pool as a whole (35%).

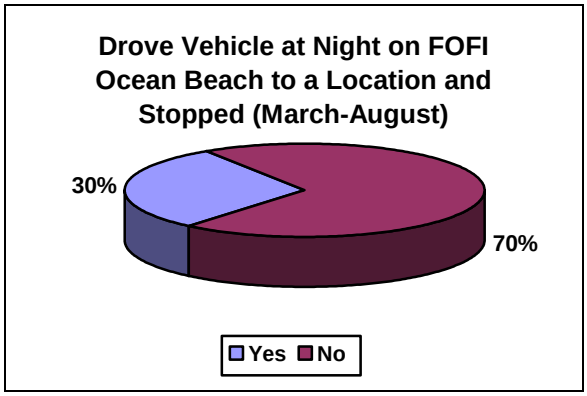


Figure 13—Percentages of Respondents Who Indicated They Drove Their Vehicle at Night to a Specific Spot on the Ocean Beach at FOFI, Stopped and Remained in that Location for the Duration of Their Visit Between March and August

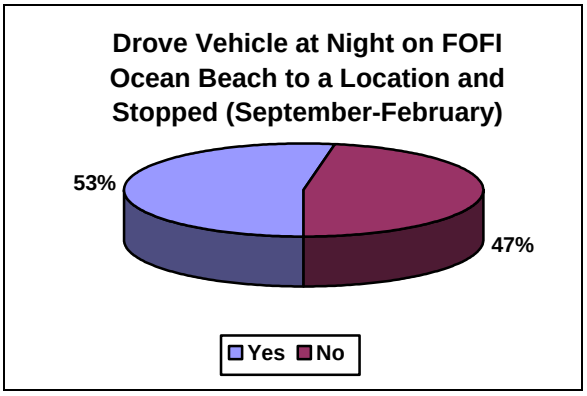


Figure 14—Percentages of Respondents Who Indicated They Drove Their Vehicle at Night to a Specific Spot on the Ocean Beach at FOFI, Stopped and Remained in that Location for the Duration of Their Visit Between September and February

Study Limitations

The results must be viewed in context of a full understanding of the parameters of the study defined by the scope of work as authorized under *North Carolina House Bill 1414-Ratified* (see prior Background section of this document). The intent of this particular phase of the study is to ascertain the demand for ocean beach vehicular access at FOFI throughout the year. However, the defining legislation limited the

study to the months of August—December 2004. This had the effect of significantly restricting both the number and type of respondents from whom data could be derived. Although vehicular counts dating from July 2nd to December 15th exist, there are no vehicular counts prior to this time period. In addition, given the imposed time constraints of the study, critical survey data could only be collected from respondents between September 15th and December 15th.

These limitations confound the analysis of data in several ways. First, the overall number of actual respondents is severely limited since neither the vehicular counts nor surveys took place over an extended period of time (i.e. a two-year period). Second, given that the survey responses were only generated from users who came to the ocean beach at FOFI during the early fall through winter months (September 15th through December 15th), the question of whether the sample truly represents the population of FOFI users throughout the year arises. Individuals who use the ocean beach at FOFI exclusively during the spring and summer months were not included in the sample pool.

Therefore, given the above limitations, any conclusions that may be derived from analysis of this data can only be generalized to vehicular users of the ocean beach at FOFI during the early fall through winter months.

Discussion and Conclusions

Although the results of this study cannot be generalized to the entire population of ocean beach vehicular users at FOFI throughout the year, certain conclusions can be reached regarding early fall through winter users.

The majority of ocean beach vehicular users at FOFI arrive in vehicles with only one or two individuals. Larger groups are infrequent. This would indicate that FOFI is not utilized as a location for large social gatherings. This is reinforced by the wide distribution of users across the oceanfront beach.

Conclusions regarding the distribution of visitation by season are the most problematic to derive. This is due to the fact that survey data was only collected between September 15th and December 15th.

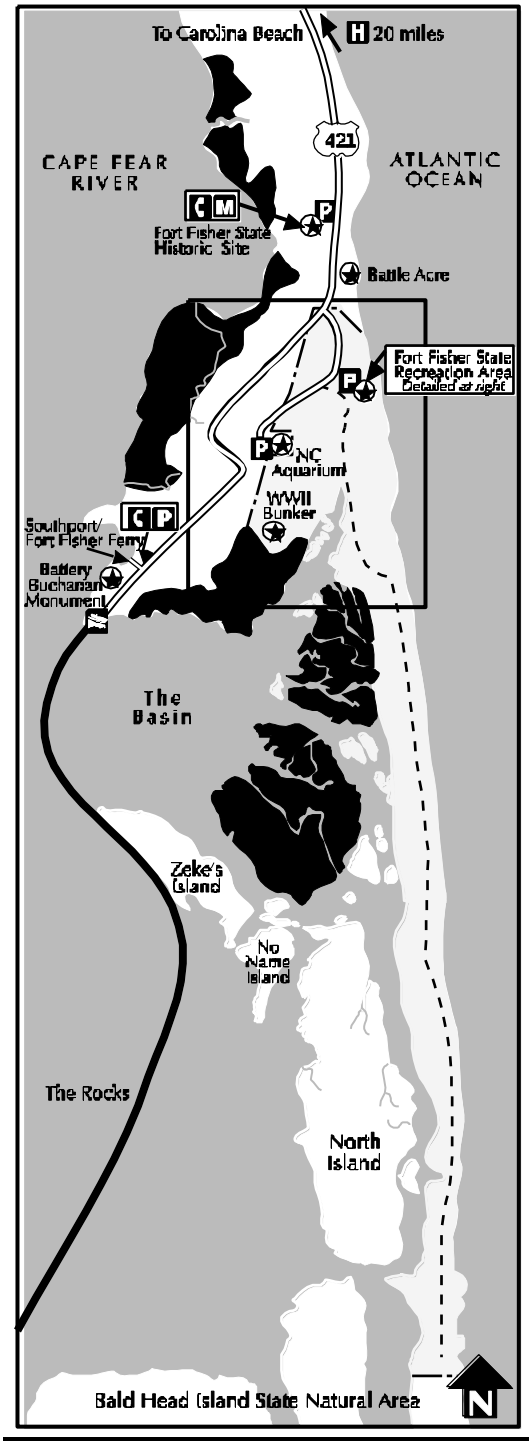
Perhaps the most relevant finding of this study is that the majority of ocean beach vehicular users at FOFI visit exclusively during the daytime hours (sunup to sundown). During the September—February time period, 73% of the users were exclusively daytime users, and during the March—August time period, the figure increases to 79%. This finding indicates that nighttime use of the ocean beach at FOFI is not significant. This is confirmed by the four-wheel drive vehicular access counts which indicate that 75% of the users entered during the daytime hours. Therefore, limiting ocean beach vehicular access to FOFI during the nighttime hours would impact a relatively small percentage of users.

Also of interest is the finding that the majority (70%) of nighttime ocean beach vehicular users at FOFI during March—August do not drive their vehicle to a specific spot on the beach, stop and remain in that location for the duration of their visit as compared to 47% of the September—February users. This would indicate that the nighttime users during March—August may be impacting critical nighttime biological functions associated with nesting sea turtles and colonial nesting water birds. However, given the inherent limitations consistent with the size and composition of the sample, this finding warrants additional investigation.

Recommendations

It would appear, based upon the available limited data, that restricting nighttime ocean beach vehicular access to FOFI would have minimal negative impact upon visitor usage and demand since the majority are daytime users. However, it would be premature to make definitive management decisions regarding ocean beach vehicular access at FOFI based upon the results of this study given the study's inherent limitations (see prior Limitations section of this document). Therefore, it is further recommended that this study be continued to cover a full two-year period. This would provide a more reliable dataset that would mitigate such limitations, and thereby support sound management decisions regarding ocean beach vehicular access at FOFI.

Appendix A—Map of Fort Fisher State Recreation Area



Appendix B—Four-Wheel Drive Vehicle Access Count

Date	Day/Night	Number of Vehicles	Reason for "No" Count or Abnormal Count
Friday, July 02, 2004	D and N	311	
Saturday, July 03, 2004	D and N	390	
Sunday, July 04, 2004	D and N	350	
Monday, July 05, 2004	D and N	212	
Sunday, July 11, 2004	D and N	160	
Monday, July 12, 2004	D and N	74	
Tuesday, July 13, 2004	D and N	76	
Wednesday, July 14, 2004	D and N	82	
Thursday, July 15, 2004	D and N	112	
Friday, July 16, 2004	D and N	91	
Saturday, July 17, 2004	D and N	265	
Sunday, July 18, 2004	D and N	177	
Monday, July 19, 2004	D and N	83	
Tuesday, July 20, 2004	D and N	75	
Wednesday, July 21, 2004	D and N	98	
Thursday, July 22, 2004	D and N	137	
Friday, July 23, 2004	D and N	85	
Saturday, July 24, 2004	D and N	256	
Sunday, July 25, 2004	D and N	172	
Monday, July 26, 2004	D and N	70	
Tuesday, July 27, 2004	D and N	40	
Wednesday, July 28, 2004	D and N	91	
Thursday, July 29, 2004	D and N	86	
Friday, July 30, 2004	D and N	132	
Saturday, July 31, 2004	D and N	223	
Sunday, August 01, 2004	D and N	152	
Monday, August 02, 2004	D and N	63	
Tuesday, August 03, 2004	D and N	99	
Wednesday, August 04, 2004	D and N	76	
Thursday, August 05, 2004	D and N	93	
Friday, August 06, 2004	D and N	105	
Saturday, August 07, 2004	D and N	291	
Sunday, August 08, 2004	D and N	280	
Monday, August 09, 2004	D and N	73	
Tuesday, August 10, 2004	D and N	77	
Wednesday, August 11, 2004	D and N	51	
Thursday, August 12, 2004	D and N	66	
Friday, August 13, 2004	D and N	64	
Saturday, August 14, 2004			Closed for Hurricane Charlie
Sunday, August 15, 2004	D and N	95	
Monday, August 16, 2004	D and N	64	
Tuesday, August 17, 2004	D and N	70	
Wednesday, August 18, 2004	D and N	91	

Thursday, August 19, 2004	D and N	100	
Friday, August 20, 2004	D and N	138	
Saturday, August 21, 2004	D and N	287	
Sunday, August 22, 2004	D and N	263	
Monday, August 23, 2004	D and N	222	
Tuesday, August 24, 2004	D and N	42	
Wednesday, August 25, 2004	D and N	33	
Thursday, August 26, 2004	D and N	113	
Friday, August 27, 2004	D and N	54	
Saturday, August 28, 2004	D and N	167	
Sunday, August 29, 2004	D and N	63	
Monday, August 30, 2004	D and N	48	
Tuesday, August 31, 2004	D and N	50	
Wednesday, September 01, 2004	D and N	12	
Thursday, September 02, 2004	D and N	46	
Friday, September 03, 2004	D and N	79	
Saturday, September 04, 2004	D and N	162	
Sunday, September 05, 2004	D and N	214	
Monday, September 06, 2004	D and N	66	
Tuesday, September 07, 2004	D and N	20	
Wednesday, September 08, 2004	D and N	36	
Thursday, September 09, 2004	D and N	52	
Friday, September 10, 2004	D and N	51	
Saturday, September 11, 2004	D and N	107	
Sunday, September 12, 2004	D and N	289	
Monday, September 13, 2004	D and N	55	
Tuesday, September 14, 2004	D and N	60	
Wednesday, September 15, 2004			Counter Malfunctioning
Thursday, September 16, 2004			Counter Malfunctioning
Friday, September 17, 2004			Counter Malfunctioning
Saturday, September 18, 2004			Counter Malfunctioning
Sunday, September 19, 2004			Counter Malfunctioning
Monday, September 20, 2004			Counter Malfunctioning
Tuesday, September 21, 2004			Counter Malfunctioning
Wednesday, September 22, 2004			Counter Malfunctioning
Thursday, September 23, 2004			Counter Malfunctioning
Thursday, September 23, 2004	N	12	
Friday, September 24, 2004	D	72	
Friday, September 24, 2004	N	23	
Saturday, September 25, 2004	D	183	
Saturday, September 25, 2004	N	10	
Sunday, September 26, 2004	D	55	
Sunday, September 26, 2004	N	34	
Monday, September 27, 2004	D	264	
Monday, September 27, 2004	N	30	
Tuesday, September 28, 2004	D	80	
Tuesday, September 28, 2004	N	41	

Wednesday, September 29, 2004	D	101	
Wednesday, September 29, 2004	N	55	
Thursday, September 30, 2004	D	100	
Thursday, September 30, 2004	N	38	
Friday, October 01, 2004	D	152	Surf Fishing Tournament
Friday, October 01, 2004	N	239	Surf Fishing Tournament
Saturday, October 02, 2004	D	571	Surf Fishing Tournament
Saturday, October 02, 2004	N	239	Surf Fishing Tournament
Sunday, October 03, 2004	D	415	Surf Fishing Tournament
Sunday, October 03, 2004	N	110	Surf Fishing Tournament
Monday, October 04, 2004	D	112	
Monday, October 04, 2004	N	33	
Tuesday, October 05, 2004	D	120	
Tuesday, October 05, 2004	N	25	
Wednesday, October 06, 2004	D	13	
Wednesday, October 06, 2004	N	30	
Thursday, October 07, 2004	D	73	
Thursday, October 07, 2004	N	11	
Friday, October 08, 2004	D	26	
Friday, October 08, 2004	N	94	
Saturday, October 09, 2004	D	240	
Saturday, October 09, 2004	N	43	
Sunday, October 10, 2004	D	220	
Sunday, October 10, 2004	N	35	
Monday, October 11, 2004	D	59	
Monday, October 11, 2004	N	21	
Tuesday, October 12, 2004	D	134	
Tuesday, October 12, 2004	N	18	
Wednesday, October 13, 2004	D	41	
Wednesday, October 13, 2004	N	6	
Thursday, October 14, 2004	D	62	
Thursday, October 14, 2004	N	6	
Friday, October 15, 2004	D	57	
Friday, October 15, 2004	N	29	
Saturday, October 16, 2004	D	170	
Saturday, October 16, 2004	N	32	
Sunday, October 17, 2004	D	123	
Sunday, October 17, 2004	N	20	
Monday, October 18, 2004	D	60	
Monday, October 18, 2004	N	7	
Tuesday, October 19, 2004	D	43	
Tuesday, October 19, 2004	N	15	
Wednesday, October 20, 2004	D	48	
Wednesday, October 20, 2004	N	31	
Thursday, October 21, 2004	D	48	
Thursday, October 21, 2004	N	11	
Friday, October 22, 2004	D	64	

Friday, October 22, 2004	N	28	
Saturday, October 23, 2004	D	83	
Saturday, October 23, 2004	N	21	
Sunday, October 24, 2004	D	61	
Sunday, October 24, 2004	N	11	
Monday, October 25, 2004	D	27	
Monday, October 25, 2004	N	8	
Tuesday, October 26, 2004	D	52	
Tuesday, October 26, 2004	N	20	
Wednesday, October 27, 2004	D	43	
Wednesday, October 27, 2004	N	8	
Thursday, October 28, 2004	D	60	
Thursday, October 28, 2004	N	11	
Friday, October 29, 2004	D	54	
Friday, October 29, 2004	N	61	
Saturday, October 30, 2004	D	194	
Saturday, October 30, 2004	N	60	
Sunday, October 31, 2004	D	127	
Sunday, October 31, 2004	N	15	
Monday, November 01, 2004	D	39	
Monday, November 01, 2004	N	6	
Tuesday, November 02, 2004	D	29	
Tuesday, November 02, 2004	N	10	
Wednesday, November 03, 2004	D	25	
Wednesday, November 03, 2004	N	6	
Thursday, November 04, 2004	D	23	
Thursday, November 04, 2004	N	12	
Friday, November 05, 2004	D	37	
Friday, November 05, 2004	N	23	
Saturday, November 06, 2004	D	100	
Saturday, November 06, 2004	N	38	
Sunday, November 07, 2004	D	80	
Sunday, November 07, 2004	N	16	
Monday, November 08, 2004	D	14	
Monday, November 08, 2004	N	3	
Tuesday, November 09, 2004	D	10	
Tuesday, November 09, 2004	N	4	
Wednesday, November 10, 2004	D	10	
Wednesday, November 10, 2004	N	3	
Thursday, November 11, 2004	D	33	
Thursday, November 11, 2004	N	7	
Friday, November 12, 2004	D	20	
Friday, November 12, 2004	N	10	
Saturday, November 13, 2004	D	49	
Saturday, November 13, 2004	N	10	
Sunday, November 14, 2004	D	15	
Sunday, November 14, 2004	N	8	

Monday, November 15, 2004	D	18	
Monday, November 15, 2004	N	6	
Tuesday, November 16, 2004	D	24	
Tuesday, November 16, 2004	N	11	
Wednesday, November 17, 2004	D	26	
Wednesday, November 17, 2004	N	6	
Thursday, November 18, 2004	D	29	
Thursday, November 18, 2004	N	4	
Friday, November 19, 2004	D	65	
Friday, November 19, 2004	N	13	
Saturday, November 20, 2004	D	61	
Saturday, November 20, 2004	N	16	
Sunday, November 21, 2004	D	32	
Sunday, November 21, 2004	N	4	
Monday, November 22, 2004	D	8	
Monday, November 22, 2004	N	6	
Tuesday, November 23, 2004	D	10	
Tuesday, November 23, 2004	N	5	
Wednesday, November 24, 2004	D	17	
Wednesday, November 24, 2004	N	8	
Thursday, November 25, 2004	D	37	
Thursday, November 25, 2004	N	9	
Friday, November 26, 2004	D	49	
Friday, November 26, 2004	N	14	
Saturday, November 27, 2004	D	87	
Saturday, November 27, 2004	N	12	
Sunday, November 28, 2004	D	30	
Sunday, November 28, 2004	N	6	
Monday, November 29, 2004	D	10	
Monday, November 29, 2004	N	7	
Tuesday, November 30, 2004	D	5	
Tuesday, November 30, 2004	N	5	
Wednesday, December 01, 2004	D	7	
Wednesday, December 01, 2004	N	0	
Thursday, December 02, 2004	D	5	
Thursday, December 02, 2004	N	4	
Friday, December 03, 2004	D	5	
Friday, December 03, 2004	N	1	
Saturday, December 04, 2004	D	12	
Saturday, December 04, 2004	N	2	
Sunday, December 05, 2004	D	15	
Sunday, December 05, 2004	N	3	
Monday, December 06, 2004	D	9	
Monday, December 06, 2004	N	0	
Tuesday, December 07, 2004	D	10	
Tuesday, December 07, 2004	N	0	
Wednesday, December 08, 2004	D	16	

Wednesday, December 08, 2004	N	0	
Thursday, December 09, 2004	D	2	
Thursday, December 09, 2004	N	2	
Friday, December 10, 2004	D	7	
Friday, December 10, 2004	N	0	
Saturday, December 11, 2004	D	22	
Saturday, December 11, 2004	N	0	
Sunday, December 12, 2004	D	12	
Sunday, December 12, 2004	N	0	
Monday, December 13, 2004	D	13	
Monday, December 13, 2004	N	0	
Tuesday, December 14, 2004	D	16	
Tuesday, December 14, 2004	N	0	
Wednesday, December 15, 2004	D/N	5/0	

Appendix C—Ocean Beach Vehicular Access Survey

Ocean Beach Vehicular Access Survey—Fort Fisher State Recreation Area

Hello, I'm_____ from the University of North Carolina at Wilmington and we are conducting an Ocean Beach Vehicular Access study at the Fort Fisher State Recreation Area. I would appreciate your answering a few questions about your vehicular use of the Fort Fisher State Recreation Area. Your participation in this survey is entirely voluntary and will likely take less than two minutes. All answers will be kept confidential. Would you be willing to answer a few questions? (If they respond YES, go to Question #1. If they respond NO, thank them for their time and terminate the interview)

Date of Interview: _____ Time of Interview: _____

1. Are you 18 years of age or older?
   a. _____ Yes (Proceed to Question #2)
   b. _____ No (TERMINATE INTERVIEW and thank them)
2. Including today/tonight, approximately how many times during the previous 12 months have you driven your vehicle on the ocean beach here at the Fort Fisher State Recreation Area:
   _____ in the spring and summer (March – August)?
   _____ how many of these spring and summer trips included night driving on the beach?
   _____ how many of these night driving trips were EXCLUSIVELY night driving (no day driving at all on the beach)?
   _____ how about in the fall and winter (September – February)?
   _____ how many of these fall and winter trips included night driving on the beach?
   _____ how many of these night driving trips were EXCLUSIVELY night driving (no day driving at all on the beach)?
3. When you come to the Fort Fisher State Recreation Area, do you normally drive your vehicle to a specific spot on the beach, stop and remain in that one location?
   _____Yes → go to Question #4
   _____No → go to Question #5
4. Would you please identify on this map the spot that you normally drive your vehicle to on the beach? (Mark the response on the map)
5. What is your zip code? _____
6. What is your primary occupation (job)? _____
7. How much money do you typically spend on a typical trip, PER PERSON, in the Carolina Beach/Kure Beach area on the following things?

Hotel/Motel	_____ ($ per person)
Restaurants and Bars	_____ ($ per person)
Other Food and Beverages (Groceries)	_____ ($ per person)
Fishing and Beach Supplies	_____ ($ per person)
Gasoline	_____ ($ per person)

8. If this beach had been closed today/tonight, what would you have done instead? _____

_____

_____

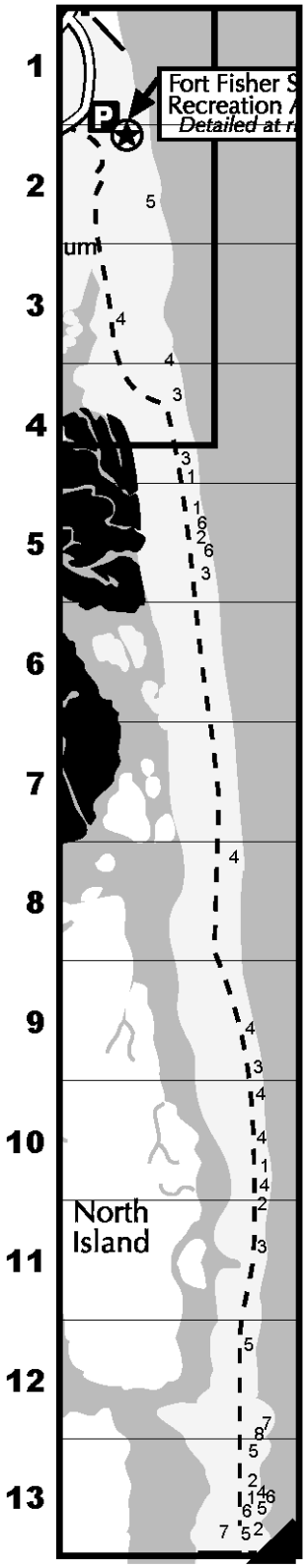
Thank you very much for your time.

Record: 1 - Male 2 – Female
Record: Number of individuals in the vehicle _____
Record: (If you encounter a vehicle that refuses to answer the survey) Number of individuals in the vehicle_____

Appendix D—Survey Schedule

Date	Time	Number of Surveys
Wednesday, September 15th	5:00 pm – 8:00 pm	8
Saturday, September 18th	11:00 pm – 2:00 am	2
Wednesday, October 13th	9:00 am – 12 noon	4
Friday, October 15th	9:00 pm – 12 midnight	3
Monday, October 18th	1:00 pm – 4:00 pm	23
Thursday, October 21st	11:00 pm – 2:00 am	2
Sunday, October 24th	2:00 pm – 5:00 pm	32
Tuesday, October 26th	8:00 pm – 11:00 pm	3
Saturday, October 30th	11:00 am – 2:00 pm	48
Sunday, October 31st	6:00 pm – 9:00 pm	4
Monday, November 8th	10:00 pm – 1:00 am	0
Saturday, November 13th	1:00 pm – 4:00 pm	24
Saturday, November 13th	11:00 pm – 2:00 am	0
Wednesday, November 17th	9:00 pm – 12 midnight	0
Sunday, November 21st	8:00 am – 11:00 am	8
Tuesday, November 23rd	4:00 pm – 7:00 pm	0
Monday, November 29th	9:00 am – 12 noon	0
Saturday, December 4th	10:00 am – 1:00 pm	8
Thursday, December 9th	2:00 pm – 5:00 pm	0
Friday, December 10th	9:00 am – 12 noon	3
Friday, December 10th	4:00 pm – 7:00 pm	0
Saturday, December 11th	10:00 am – 1:00 pm	7
Sunday, December 12th	9:00 am – 12 noon	0
Monday, December 13th	6:00 pm – 9:00 pm	1
Tuesday, December 14th	9:00 am – 12 noon	1
Wednesday, December 15th	2:00 pm – 5:00 pm	0

Appendix E—Distribution of Stationary FOFI Ocean Beach Vehicular Users



Reference Number	Survey Date and Time Period
1	September 15, 2004 5:00-8:00pm
2	October 13, 2004 9:00am-12:00noon
3	October 18, 2004 1:00-4:00pm
4	October 24, 2004 2:00-5:00pm
5	November 13, 2004 1:00-4:00pm
6	November 21, 2004 8:00-11:00am
7	December 11, 2004 10:00am-1:00pm
8	December 13, 2004 6:00-9:00pm

II. Biological Impacts

Submitted by:

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INTRODUCTION AND SCOPE OF WORK

The purpose of this investigation is to use the best available data to determine the direct and indirect effects of vehicular access on Endangered, Threatened, and Significantly Rare species that use the Fort Fisher State Recreation Area (FOFI), as directed by 2004 N.C. House Bill 1414, Section 12.3(b).

PAST BIOLOGICAL STUDIES IN THE FORT FISHER REGION

In the late 1970's and early 1980's, personnel at the University of North Carolina at Wilmington (Paul Hosier, Tom Eaton, Medha Kochhar, Paul Thayer, and I) conducted a series of broad-based studies at FOFI and the north end of Bald Head Island to examine the impact of off-road vehicles (ORVs) on flora and fauna in the region. We used FOFI as our disturbed, experimental site and the north end of Bald Head Island as our undisturbed, control site—the study sites were separated by an inlet in those days, so there was no corridor for dispersal between the islands. One study found reduced plant diversity and abundance at FOFI compared to that on the north end of Bald Head Island (Hosier and Eaton, 1980). Another study determined that ORV tracks prevented hatchling sea turtles from reaching the ocean (Hosier et al., 1980). The final study found that mammalian community structure was altered by chronic ORV use, as small mammal populations were three times greater on FOFI than on the north end of Bald Head Island due to a dearth of predators (snakes, foxes, and many raptors) that were present on the north end of Bald Head Island (Webster et al., 1980). It should be mentioned that ORV drivers regularly drove over dunes and into the salt marsh at that time and that the landscape was much more disturbed than it is today.

In addition, there has been extensive survey work on the barrier beaches adjacent to FOFI during the last 25 years. The Bald Head Island Conservancy (BHIC) and the University of North Carolina at Wilmington (UNCW) have monitored nesting sea turtles on Bald Head Island since the early 1980s and they also have monitored shorebird and colonial waterbird populations on Bald Head Island on occasion. Personnel with the N.C. Wildlife Resources Commission (NCWRC) have assisted with sea turtle monitoring throughout the region (they organize volunteers to patrol

beaches for nesting sea turtles) and they have attempted to conduct annual surveys for breeding, migrating, and resident birds throughout the region. My graduate students and I also have monitored sea turtles on Masonboro Island and Wrightsville Beach irregularly since 1984, and we have monitored Figure Eight Island and the north end of Wrightsville Beach for all Endangered, Threatened, and Significantly Rare species since 1999. Charlie Baker has been monitoring Figure Eight Island for sea turtles since the early 1980s and he continues to participate in the UNCW study now. Personnel at the Fort Fisher Aquarium, National Audubon Society, Carolina Beach State Park (now Fort Fisher State Recreation Area), U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, and several graduate students at UNCW also have participated in an impressive number of floral and faunal surveys in the region.

All told, a tremendous amount of research has been conducted on the Endangered, Threatened, and Significantly Rare species in the Fort Fisher area. Therefore, there is a wealth of biological information that documents the importance of barrier island communities to Endangered, Threatened, and Significantly Rare species in southeastern North Carolina, and there are a significant number of studies that directly and indirectly document how ORV use affects the Endangered, Threatened, and Significantly Rare species that frequent FOFI. This study incorporates approximately 25 years of data but focuses on the last five years of data to ascertain the effects of ORVs on Endangered, Threatened, and Significantly Rare species at Fort Fisher State Recreation Area.

DESCRIPTION OF HABITAT TYPES IMPORTANT TO THIS INVESTIGATION

Biological data were collected for Endangered, Threatened, and Significantly Rare species for a five-year period from 2000-2004, focusing on five “islands” in southeastern North Carolina. The focal species were sea turtles (both loggerheads and greens), nesting and migrating shorebirds (Piping Plover, Wilson’s Plover, American Oystercatcher, Willet), nesting and migrating colonial waterbirds (Black Skimmer, Least Tern, Common Tern), and seabeach amaranth (an annual plant endemic to the Upper Beach Community of Schafale and Weakley, 1990). The five islands included in this investigation are, from north to south, Figure Eight Island, Wrightsville Beach, Masonboro Island, Fort Fisher State Recreation Area, and Bald Head Island.

“Islands” is a vague term in this investigation because inlets open and close, sometimes in the course of only a few days. Inlets also migrate, which is important in this investigation because the constant shifting of sand in inlet areas maintains a wider array of habitat types, particularly large expanses of sandbars and mudflats isolated by channels and sloughs. Thus, inlet areas have the greatest amount of habitat diversity of any coastal system. Moreover, because this assortment of habitat

types is in close proximity, inlet areas are important foraging, socializing, and resting areas for colonial waterbirds and shorebirds, including Piping Plovers, Wilson's Plovers, American Oystercatchers, Willets, Least Terns, Common Terns, and Black Skimmers. In addition, seabeach amaranth germinates in sandy open areas in inlet areas. Therefore, management measures designed to safeguard one species in the inlet community invariably safeguard many.

Ocean-facing beachfront habitat, the Upper Beach Community (Schafale and Weakley, 1990), is another coastal habitat that is important to this investigation. Compared to the inlet area, the Upper Beach Community is relatively stable and there is less habitat diversity. Although storms and water can cause pronounced erosion and accretion of sand at times, the continued long-term effect of wind and salt are the primary agents in determining community structure. The Upper Beach Community is characterized by widely to moderately scattered plants, such as sea oats, that are tolerant of these conditions. These pioneer plants trap sand and dunes eventually grow, provided storms do not sweep the beach clean and start the dune-building process anew. The Upper Beach Community is used by nesting and incubating sea turtles, nesting and migrating shorebirds, and seabeach amaranth. Again, management programs that protect one species in the beachfront community invariably protect many.

Proceeding landward from the beachfront community, the dune community has more vertical relief than other barrier beach communities, thereby marking the division between ocean-facing and marsh-facing communities. Community structure behind the dunes is more variable and directly dependent on dune height and inversely dependent on the amount of salt spray affecting its vegetation (i.e., wide islands with tall dunes have more floristic and faunistic diversity than do narrow islands with low dunes). Sea turtles frequently nest on the seaward side of dunes and shorebirds nest in the dune and open hind-dune communities as well.

Another characteristic habitat of barrier islands is formed when storms breech dune lines, developing sandy washover fans that extend into the salt marsh. These barren sandflats are important nesting habitat for several species of shorebirds and colonial waterbirds and they sometimes are colonized by seabeach amaranth. In addition, diamond-backed terrapins traverse these washover fans as they search for nesting sites on adjacent uplands.

Salt marshes are another important habitat used by shorebirds and colonial waterbirds. Tidally exposed mudflats are critical foraging habitat for shorebirds, and sandbars are important areas for loafing and socializing shorebirds and colonial waterbirds. Tidally exposed mudflats also are critically important staging areas where migrating shorebirds and colonial waterbirds forage, rest, and prepare for the next leg of their journey. Other barrier island habitats, such as maritime forests and freshwater ponds, are not included herein because they are not the focus of this investigation.

METHODS

Biological data used in this investigation were compiled by personnel in the Department of Biological Sciences at the University of North Carolina at Wilmington, N.C. Wildlife Resources Commission, Fort Fisher State Recreation Area, and Bald Head Island Conservancy (BHIC). Survey methods and survey effort differed among agencies, as described in the individual species accounts below. Despite these differences, it is possible to rank the results and compare the data relative to survey effort. Furthermore, the species in question are distributed more or less continuously along the narrow coastal zone in the southeastern United States, so a lack of presence data typically reflects a lack of survey effort rather than an aversion by a particular species to a particular island. In cases where comparisons could not be made, I have suggested some recommendations that would provide information in a cost-effective and expeditious manner.

In addition, nine letters were submitted by eight persons interested in the issue at hand and one public forum was held in order for interested parties to have an opportunity to provide comments. All written comments, save for one, were submitted by individuals who spoke at the forum and largely redundant in content. Several additional people spoke at the forum but did not submit letters. In general, the written and oral comments were constructive but sometimes lacking in biological acumen. Overall, about 80% of the oral and written comments were critical of the changes proposed and 20% were in favor of the compromise plan to restrict ORV access during night-time hours during the period from March 15 through September 15.

In the paragraphs below, I provide a brief description of each species and why it is considered to be endangered, threatened, or significantly rare, followed by comments about the status of that species in the study area based on the best available data and some concluding anecdotal remarks when warranted.

Loggerhead Sea Turtle

Loggerhead sea turtles nest on subtropical sandy beaches throughout the world, including the entire region included in this investigation. Females begin to come ashore in May and lay nests, each containing about 120 eggs, which incubate for approximately 66 days in southeastern North Carolina. Females nest at two-week intervals until late August, but nests continue to incubate until mid-November. Some females are extremely specific in where they nest, and they return to the same beach over time; others, however, roam north and south and nest at different beaches each time they come ashore. Given this prodigious reproductive effort, it has been estimated that only one in 10,000 hatchlings reach sexual maturity or else the oceans would be full of sea turtles. All species of sea turtles have been decimated over the last two centuries from the harvest of eggs, loss of nesting habitat, drowning of adults in fishing gear, and the detrimental effects of beachfront lighting. All species of sea

turtles are afforded protection under the Endangered Species Act (ESA)—the loggerhead is listed federally as Threatened (LeGrand et al., 2004).

Sea turtle nesting data have been collected on a daily basis from Figure Eight Island, Wrightsville Beach, FOFI, and Bald Head Island from 2000-2004. Data from Masonboro Island are largely lacking from the latter half of this period, as explained beyond. Nesting data were collected by personnel at UNCW (Figure Eight Island), volunteers organized by the NCWRC (Wrightsville Beach), FOFI (Fort Fisher State Recreation Area), and BHIC (Bald Head Island). UNCW personnel also collected nesting data on a daily basis from Masonboro Island in 2000 and 2001, but surveys were pared to alternate days in 2002, and the island was not surveyed in 2003 or 2004. Nonetheless, reports of nests were received for both 2003 and 2004 from locals that frequented Masonboro Island during the nesting season.

Female loggerheads nested on all five islands in the study area during all five years (Table 1). The most conspicuous trend in the nesting data is a subtle north-to-south increase in the nesting density from Figure Eight Island to Bald Head Island. However, this trend is obscured by low nest densities on Wrightsville Beach, where beachfront lighting is most pronounced. Beachfront development at Bald Head Island appears to be having a negative effect on its nesting sea turtles as well, when recent nesting data is compared to that from the 1980's. Despite this decline, loggerhead nesting densities at FOFI are intermediate between those at Masonboro Island and Bald Head Island.

ORV traffic apparently has had a minimal effect on nesting females at FOFI, although some females might be scared off by vehicle lights, flashlights, and other human disturbance. Sea turtle biologists use the term 'false crawl' to refer to a nesting female that comes ashore but then returns to the ocean without nesting. As nesting density declines at Bald Head Island and ostensibly Kure Beach as well, FOFI would be the closest undisturbed beach for females that false crawl there. Therefore, FOFI is an important nesting beach for resident females that regularly return there to nest and it is an important secondary nesting site for those females that relocate there from adjacent beaches where they have false crawled.

ORV traffic has profound negative affects on hatchling sea turtles. Hatchlings emerge at night so as to avoid daytime predators and the heat of the day. ORV drivers likely would not see hatchlings crawling toward the ocean at night, so without intervention by management personnel hatchlings would be crushed during night-time ORV activity. Moreover, as mentioned above, ORV tire tracks obstructed hatchlings from reaching the ocean (Hosier et al., 1980). This incompatible situation can be remedied in one of three ways—by restricting night-time ORV activity, by relocating sea turtles nests out of ORV-use zones, or by costly and time-consuming intervention by management personnel.

FOFI has a long-standing policy that prohibits night-time ORV traffic during a three-day period around the full moon (one day before, the day of, and one day after).

Local legend mistakenly alleges that sea turtles nest during the full moon. I believe this legend originates from people walking on the beach at night during a full moon, when they can see farther and more likely see a nesting sea turtle. In reality, sea turtles nest at any time during the month, and lunar periodicity has no influence on sea turtle nesting patterns. Therefore, prohibiting nighttime traffic only during the full moon affords little protection to nesting turtles.

Green sea turtle

The green sea turtle is considered to be Endangered under the ESA (LeGrand et al., 2004). Nesting green sea turtles have not been reported from FOFI, but they have been reported on rare occasions from Masonboro Island and Bald Head Island (Woodson and Webster, 1999). It is therefore likely that female green sea turtles occasionally nest at FOFI.

Diamond-backed terrapin

The diamonded-backed terrapin is widely distributed in estuarine marshes in the study area; however, it is relatively uncommon and population numbers are depleted, owing to excessive harvest for the culinary trade. Therefore, it is listed as a species of Special Concern (LeGrand et al., 2004). Few terrapin studies have been conducted in the Fort Fisher region, but declines in other parts of its range have been attributed to the plethora of active and abandoned crab traps in estuarine waters. It is included herein because nesting individuals leave the salt marsh and move onto the barrier island uplands to lay eggs.

Piping Plover

Piping Plovers breed along the East Coast of North America from the Carolinas northward into the maritime provinces of Canada. Breeding pairs nest on bare sand, primarily near inlets. Nests frequently are lost to high tides and predators, nesting success is low, and the number of nesting pairs has diminished dramatically in the last century. More recently, much of the bird's nesting habitat has been altered directly by beach-front development and indirectly as barren unstable inlets areas become densely vegetated following inlet stabilization practices. In addition, Piping Plovers are unable to spend adequate time foraging at sites with even moderate amounts of human disturbance (Burger, 1994). The East Coast Piping Plover population is listed federally as Threatened because of declining numbers and loss of habitat (LeGrand et al., 2004).

Piping Plovers are present in southeastern North Carolina almost year round; however, different groups of birds are here at different times of the year. Breeding pairs are found in southeastern North Carolina from late April until late July. Pairs that breed farther north migrate through southeastern North Carolina, beginning in July and continuing through November, as they move southward to Florida and the Bahamas. The northernmost nesting Piping Plovers, those from the Canadian

maritime provinces, arrive in southeastern North Carolina in December and stay here as winter residents until February, at which time they begin their northward spring migration. Spring migration continues throughout March and April as birds from Florida and the Bahamas move northward. Thus, four groups of Piping Plovers occur in southeastern North Carolina throughout the year: breeding pairs, fall migrants, winter residents, and spring migrants.

Piping Plover surveys (Table 2) have been conducted during the last five years (2000-2004) by UNCW (Figure Eight Island and the north end of Wrightsville Beach) and NCWRC (Masonboro Island, FOFI, and Bald Head Island) personnel. Surveys at Figure Eight Island and the north end of Wrightsville Beach have been conducted at least weekly since 2000, so these data are most reliable. Fall migrants, winter residents, and spring migrants have been observed on both islands, but breeding pairs have not been seen on either island save for a single observation of one breeding pair on Figure Eight in 2004 that likely nested on Hutaff Island, the next island to the north. Surveys for breeding Piping Plovers on Masonboro Island, FOFI, and Bald Head Island have occurred annually during the five-year study period. One breeding pair was observed at FOFI on 1 July 2002, a single adult was observed on the north end of Bald Head Island on 1 July 2000, a lone adult was observed on 4 June 2004 at FOFI, and an adult female was observed on the south end of Masonboro Island on 2 June 2004. Surveys for autumnal and spring migrants and winter residents have occurred less frequently on Masonboro Island, FOFI, and Bald Head Island, but migrants have been observed every time there was a survey and winter residents were observed on every survey except one. Fall migrants, winter residents, and spring migrants certainly inhabit these three islands and breeding adults appear there sporadically.

Wilson's Plover

Wilson's Plovers nest on sandy beaches with scant vegetation, choosing what little vegetation is present as cover for their widely spaced nests. They have low reproductive success since they construct nests in dynamic inlet and beach-front habitats where overwash and shifting sands are relatively common. Currently, they also suffer from the direct and permanent loss of habitat and the modification of remaining habitat after beach stabilization practices. The Wilson's Plover is considered to be Significantly Rare (LeGrand et al., 2004).

Surveys for breeding Wilson's Plovers have been conducted during the 2000-2004 period by personnel at UNCW (Figure Eight Island and the north end of Wrightsville Beach) and personnel at NCWRC (Masonboro Island, FOFI, and Bald Head Island). Surveys at Figure Eight Island and the north end of Wrightsville Beach have been conducted at least weekly since 2000, and nests discovered on Wrightsville Beach have been followed every 2-3 days throughout incubation to determine reproductive success. Surveys on Masonboro Island, FOFI, and Bald Head Island for breeding pairs have occurred each year during the five-year study period, but sometimes only once a year per island. Wilson's Plovers migrate southward out of our area in the

winter, so management agencies do not conduct surveys for fall and spring migrants or winter residents.

Despite obvious gaps in the data, surveys indicate that Wilson's Plovers nest on all five islands included in this investigation (Table 3). Additional survey work is needed during the breeding season to better document the number of nests on Masonboro Island, FOFI, and Bald Head Island, where it undoubtedly occurs. However, given the bird's predilection to nest in sparsely vegetated sandy habitat, which at FOFI is associated with the outer perimeter of the roped areas, additional work is needed to determine if reproductive success at FOFI is significantly different from that on adjacent islands due to a pronounced rather than a subtle edge effect with adjacent dunes and with adjacent unvegetated, greatly disturbed areas.

American Oystercatcher

American Oystercatchers lay widely spaced nests on sandy beaches with scant vegetation. Because they breed in dynamic inlet and beach-front habitats where overwash and shifting sands easily can destroy their nests, they have low reproductive success. In addition, they suffer from loss of habitat and the increase in vegetative biomass after beach stabilization practices. American Oystercatchers also nest in salt marsh habitats when inlet and beach-front habitats become unsuitable, but reproductive success in marshes is less than that in inlet and beach-front habitats (Lauro and Burger, 1989). The American Oystercatcher is considered to be Significantly Rare (LeGrand et al, 2004).

Personnel from UNCW monitored Figure Eight Island and the north end of Wrightsville Beach and personnel from the NCWRC monitored Masonboro Island, FOFI, and Bald Head Island during the period from 2000-2004 (Table 3). Surveys at Figure Eight Island and the north end of Wrightsville Beach have been conducted at least weekly since 2000, and nests discovered on both islands have been followed every 2-3 days throughout incubation to determine reproductive success. Surveys on Masonboro Island, FOFI, and Bald Head Island for breeding pairs have occurred annually during the five-year study period, but occasionally only once a year per island. Since American Oystercatchers migrate southward out of our area in the winter, management agencies typically do not conduct surveys for fall and spring migrants or winter residents.

Surveys indicate that American Oystercatchers nest on all five islands included in this investigation, despite gaps in the data that reflect a lack of widespread survey effort on some islands (nests are laid far apart, so it takes an entire day to survey several miles of beach). Additional survey work during the breeding season will better document the number of nests on Masonboro Island, FOFI, and Bald Head Island and determine if reproductive success at FOFI is significantly different from that on adjacent islands.

Willet

The Willet is a year-round resident of southeastern North Carolina that nests in moderate to thick barrier island vegetation, typically along dunes and in the hind-dune habitats. Relatively little is known about its reproduction because its nests are difficult to locate, and management personnel generally spend more time in open areas with the other protected shorebirds and colonial waterbirds included in this report. The Willet currently is not listed at the federal or state level, but it is of concern to management agencies and it has received increased attention in the last few years. It is included herein for the sake of completeness.

Willet nests have been found on every island in this investigation, including FOFI, although on many surveys Willets were not the focus of attention (Table 3). It is not possible to determine nesting density based on the nesting data available, but this secretive species is more abundant than the limited information indicates.

Least Tern

The Least Tern is a colonial nesting waterbird, meaning that its nests typically are concentrated in relatively small areas of suitable habitat. Colony size ranges to as many as 400 nests, depending on the amount of suitable habitat, which consists of barren sand near inlets, washover fans, and dredge material islands (Parnell and Soots, 1979). Least Tern colonies are prone to disturbance by predators and humans (Erwin, 1980, 1989; Massey and Fancher, 1989; Erwin et al., 2001), and they are prone to being completely destroyed by harsh weather (Cowgill, 1989) and high tides (Parnell and Soots, 1979). The Least Tern was almost completely exterminated from North Carolina in the late 1800's by plume hunters, but the species recovered slowly during the early 1900's when hunting laws were passed, demand ceased, and profits crashed. The number of nests in North Carolina has declined from 2,276 in 1977 to a low of 597 in 1989; 882 nests were counted in 1997. Therefore, the Least Tern is considered to be a species of Special Concern (LeGrand et al., 2004)

UNCW personnel monitored Figure Eight Island and the north end of Wrightsville Beach and NCWRC personnel monitored Masonboro Island, FOFI, and Bald Head Island for Least Tern nests during the period from 2000-2004 (Table 4). Surveys at Figure Eight Island and the north end of Wrightsville Beach have been conducted at least weekly since 2000, and nests discovered on both islands have been examined every 2-3 days throughout incubation to determine reproductive success. Surveys on Masonboro Island, FOFI, and Bald Head Island for breeding Least Tern pairs have occurred annually during the five-year study period, but occasionally only once a year per island. Least Terns migrate southward out of our area in the winter, so management agencies typically do not conduct surveys for fall and spring migrants or winter residents.

Based on the best available data, Least Terns nesting apparently do not nest on all islands included in this study; however, survey effort varied both among years and islands. Least Terns nested on the south end of Figure Eight Island in 2000, although nest numbers were not determined, and they laid approximately 50 nests there in 2001. Least Terns laid five nests on the north end of Figure Eight Island in 2002, they did not nest on either end of Figure Eight Island in 2003, and they laid 12 nests on the north end in 2004. Least Terns did not nest on the north end of Wrightsville Beach in 2000, 2001, or 2002, but they nested there in 2003 and 2004, laying 202 and 369 nests, respectively. Changes in nest numbers between the south end of Figure Eight Island 2000 and 2001 and the north end of Wrightsville Beach in 2003 and 2004 are an artifact of the Mason Inlet Relocation Project. Least Terns did not nest on either side of Mason Inlet in 2002 when the area was heavily disturbed by construction equipment and human disturbance.

Least Terns have nested on Masonboro Island more or less continually since colonial waterbird surveys began in 1977, including each year included in this investigation. A total of 327 nests was laid on Masonboro Island in 1977, an unspecified number were laid in 2000, 99 were laid in 2001, 150 were laid in 2002, 115 were laid in 2003, and an unspecified number were laid in 2004. Due to its low relief, Masonboro Island has an extensive number of young to old washover fans that have been used by Least Terns. As these fans become overgrown with vegetation, Least Terns move to newer, unvegetated fans. Nest numbers therefore reflect the amount of barren sand available for nesting.

At FOFI, Least Terns were prevalent when colonial waterbird surveys were begun. For example, 22 nests were laid at New Inlet in 1977 (Parnell and Soots, 1979). However, ORV traffic has rendered this site inhospitable for Least Terns and they seldom nest there now. Three nests were laid in 2001, but otherwise no nests were laid at FOFI in 2000, 2002, 2003, or 2004. Least Terns apparently did not nest at Bald Head Island any time during the study period.

Since it prefers large open sandy beaches and washover fans for nesting activities, the Least Tern would benefit greatly if ORV access at FOFI was prohibited. In fact, Least Terns apparently avoid beaches impacted by ORV traffic and then return once ORV traffic is prohibited (Gochfeld, 1983). Human and predator disturbance also has a negative effect on nesting success, so roping off large expanses of foredune and dune-break areas will be necessary to attain this goal (Erwin, 1980, 1989; Erwin et al., 2001; Rimmer and Deblinger, 1992).

Common Tern

Common Terns are much less common than Least Terns in the study area. They suffer from the same perils mentioned above, but are much more susceptible to disturbance and therefore are considered to be a species of Special Concern (LeGrand et al., 2004). The total number of Common Tern nests in North Carolina has steadily declined from 4,885 in 1977, when NCWRC surveys began, to 1,699 in

1995 (Parnell et al., 1997) and then to 952 in 1997, primarily due to the loss of nesting habitat and colony disturbance. Individual colonies can have as many as 500 nests.

UNCW personnel have conducted weekly surveys on Figure Eight Island and the north end of Wrightsville Beach (Table 4), where Common Tern nests were followed every 2-3 days throughout incubation to determine reproductive success. NCWRC personnel annually monitored Masonboro Island, FOFI, and Bald Head Island for breeding pairs during the period from 2000-2004, although sometimes only once a year per island (Table 4).

Although nest numbers were not counted, my field notes indicate that Common Terns nested on the south end of Figure Eight Island in 2000. Common Terns laid approximately 20 nests on the south end of Figure Eight Island in 2001 but they did not nest there in 2002, 2003, or 2004, as the southern end of the island by that time had been added to the north end of Wrightsville Beach as a result of the Mason Inlet Relocation Project. There were no Common Tern nests on the north end of Wrightsville Beach in 2000, 2001, or 2002, but there were two Common Tern nests on the north end of Wrightsville Beach in 2003 and four nests there in 2004. Seventeen Common Tern nests were found on the north end of Masonboro Island in 1977 (Parnell and Soots, 1979), one nest was found on Masonboro Island in 1997, and three nests were found on Masonboro Island in 2001. Common Tern nests were not found throughout the remainder of the study area during the study period.

Common Terns suffer from two primary threats during their nesting season: ORV and pedestrian traffic and predation by gulls, raccoons, foxes, and rats (Parnell and Soots, 1979; Erwin, 1989; Erwin et al., 2001; O'Connell and Beck, 2003) and gull density increases proportionately with human density, causing Common Tern reproductive success to plummet (Erwin, 1980). It is likely that Common Terns nested throughout the region, including FOFI, prior to coastal development. They require large expanses of undisturbed sparsely vegetated sandflats in which to nest successfully, and this habitat currently does not exist at FOFI. Reclamation of areas used by ORVs would likely result in the re-establishment of Common Tern nesting colonies at FOFI.

Black Skimmer

Black Skimmers typically nest in the same type of habitat that is used by Common Terns—open to sparsely vegetated sandy areas near inlets and on dredge-spoil islands (Parnell and Soots, 1979), although hatching success is higher on natural beaches (Mallach and Leberg, 1999). Black Skimmers nest in concentrations as large as 250 nests or so. They suffer primarily on the breeding grounds due to predation (O'Connell and Beck, 2003) and high tides, which can wash out entire colonies (Parnell and Soots, 1979). In particular, gull predation is more pronounced in areas with higher human densities (Erwin, 1980) and reproductive success in Black Skimmers is inversely correlated with human disturbance (Safina and Burger,

1983; Erwin, 1989). Because of these problems, the Black Skimmer is considered to be a species of Special Concern (LeGrand et al., 2004).

Surveys for breeding Black Skimmer pairs (Table 4) have been conducted during the last five years (2000-2004) by personnel at UNCW (Figure Eight Island and the north end of Wrightsville Beach) and at NCWRC (Masonboro Island, FOFI, and Bald Head Island). Surveys at Figure Eight Island and the north end of Wrightsville Beach have been conducted at least weekly since 2000, where nests were followed every 2-3 days throughout incubation to determine reproductive success. Black Skimmer colonies at Masonboro Island, FOFI, and Bald Head Island have been surveyed each year during the five-year study period, but sometimes only once a year per island. In addition, NCWRC personnel surveyed Masonboro Island and FOFI in 1997 and 1999 for nesting colonial waterbirds, and those results are mentioned here as well. Although Black Skimmers are year-round residents in southeastern North Carolina, management agencies typically do not conduct surveys for fall and spring migrants or winter residents.

Black Skimmers laid nests on Figure Eight Island in 2000, but the number of nests was not recorded, and they laid approximately 40 nests there in 2001. Black Skimmers did not nest on Figure Eight Island in 2002, 2003, or 2004 because the southern end of the island, the site used in 2000 and 2001, had been added by that time to the north end of Wrightsville Beach as a result of the Mason Inlet Relocation Project. There were no Black Skimmer nests at the north end of Wrightsville Beach in 2000 or 2001, but there were four nests at the north end of Wrightsville Beach in 2002, 166 nests there in 2003, and 64 nests there in 2004. Black Skimmer nests have been recorded on Masonboro Island—57 nests in 1977 (Parnell and Soots, 1979), 1 nest in 1997, 12 nests in 1999, and 41 nests in 2001. At FOFI, 59 Black Skimmer nests were recorded in 1977 (Parnell and Soots, 1979), 16 were recorded in 1997, and 41 were recorded in 1999. Otherwise, Black Skimmer nests were not found throughout the remainder of the study area during the study period.

The Black Skimmer nests throughout the region in question, but nest numbers differ from year to year and from island to island based upon which island has the largest amount of open to sparely vegetated sandy areas in that year. Large colonies nested on Masonboro Island in the 1970's, 1980's, and 1990's and it is likely that large colonies would nest at FOFI if ORV traffic was prohibited.

Seabeach Amaranth

Seabeach amaranth is a rare denizen of barrier island beaches along the East Coast of North America. It colonizes highly dynamic beachfront and inlet habitats that are characterized by shifting sands and a dearth of vascular vegetation, especially wide, exposed sandy areas such as overwash fans, accreting ends of islands, and supratidal dunefront areas, or the Upper Beach Community of Schafale and Weakley (1990). It is a low-growing annual plant that typically begins to germinate in late spring and therefore serves as an important pioneer in ecological succession by

trapping windblown sand and providing temporary stability to ocean-facing beaches during the summer and autumn months (Weakley and Bucher, 1992). Seabeach amaranth is considered to be a 'fugitive species' because its spatial distribution is unpredictable and an artifact of three factors: it is an annual that dies at the end of each growing season; it lives in a highly dynamic environment that changes rapidly over time; and it depends on tides, storms, and hurricanes for long-distance dispersal (Mangels, 1991). As such, its distribution and abundance varies dramatically over time and space (Weakley et al., 1996).

Amaranthus pumilus has become extirpated throughout much of its historic range. It once occurred widely in nine states from Massachusetts southward to South Carolina, but it now occurs in relatively small, isolated pockets of remaining suitable habitat in New York, New Jersey, Delaware, Maryland, Virginia, North Carolina, and South Carolina (Belden, 2000; Lea, 1999; McAvoy, 2002; Murdock, 1993; Radis, 2002). Declines throughout its range in both the number of populations and the total number of individuals have been attributed to beachfront development, beach stabilization efforts, off-road vehicles, and herbivory by webworms. *Amaranthus pumilus* was listed as Threatened by the U.S. Fish and Wildlife Service (USFWS) on 7 April 1993 (Murdock, 1993), and its recovery plan was approved by USFWS on 12 November 1996 (Weakley et al., 1996). Delisting will be considered when seabeach amaranth populations inhabit at least 75% of sites with suitable habitat in six of nine historically occupied states for a period of 10 consecutive years (Weakley et al., 1996).

Seabeach amaranth surveys have been conducted on an irregular basis in the FOFI study area (Weakley and Bucher, 1992; Webster, 2005). An average of 698 (range 3-2949) plants was found at Figure Eight Island in 1987, 1988, 1990, 2002, 2003, and 2004. An average of 488 (range 0-2935) plants was found at Wrightsville Beach in 1979, 1985, 1986, 1987, 1988, 1990, 2002, 2003, and 2004. An average of 218 (range 118-317) plants was found at Masonboro Island in 1988 and 1990. An average of 1 plant (range 0-3) was found at FOFI in 1987, 1988, and 1990. An average of 6 plants was found on the east beach of Bald Head Island in 1987, 1988, and 1990. These population sizes were categorized as good (Figure Eight Island, Wrightsville Beach, Masonboro Island) and poor (FOFI, Bald Head Island) by Weakley and Bucher (1992).

ORV traffic has mixed effects on seabeach amaranth, depending on the season. ORV traffic during the dormant season generally has little effect on seeds, unless it causes "massive physical erosion and degradation of the site, such as can be seen at the northern end of Carolina Beach" (Weakley et al., 1996:16). However, some ORV traffic during the dormant season might be beneficial to seabeach amaranth since it prevents the widespread establishment of perennial grasses and shrubs, but only if those areas are closed to ORV traffic during the growing season. "The brittle, fleshy stems are easily broken, and growing plants do not generally survive a single pass by a truck tire" (Weakley et al., 1996:17). Although seabeach amaranth should

occur in the Upper Beach Community at FOFI, it is doubtful that it has been successful in dealing with decades of ORV traffic.

RESPONSE TO COMMENTS BY THE PUBLIC

I have responded to comments submitted by the public where appropriate in the species accounts above, save for three that are discussed here. One person questioned if ORV traffic exacerbated erosion rates at Rams Gate Road. This question is beyond the scope this investigation and well beyond my field of expertise, so it is not pursued here.

The second comment that has not received attention above posed the question, and I paraphrase here, if heavy ORV traffic was beneficial to protected species by keeping predators away from FOFI. It is true that predators were largely lacking at FOFI when we conducted our broad-based studies in the late 1970's and early 1980's and that they are present throughout the region today. It is therefore likely that predation pressure is greater today than it was when those studies were conducted. However, it is important to stress that ORV traffic was not regulated in the late 1970's and early 1980's and there was little, if any, reproductive success in the few Endangered, Threatened, and Significantly Rare species that existed at FOFI at that time. The number of Endangered, Threatened, and Significantly Rare species increased after ORV traffic was prohibited from the dune community and some of the salt marsh community, so reproductive success increased perforce. This portends that reproductive success in Endangered, Threatened, and Significantly Rare species will increase even more if ORV traffic is completely prohibited at FOFI and be similar to reproductive success rates observed at other state and national parks in North Carolina (e.g., Hammock's Beach State Park, Cape Hatteras National Seashore, and Cape Lookout National Seashore).

The final comment dealt with the rationale used to close parts of FOFI to ORV traffic, especially salt marsh areas. ORV traffic compresses soils in intertidal areas, both on the ocean and sound sides of barrier islands, rendering it unsuitable for invertebrates such as bloodworms and clamworms (Weber and Haig, 1996). These invertebrates are the primary forage species for a variety of shorebirds, including those Endangered, Threatened, and Significantly Rare shorebird species mentioned above. Barrier islands consist of a variety of habitats for nesting, foraging, resting, loafing, and socializing shorebirds and colonial waterbirds. If any one habitat is degraded, by any means, then the entire system becomes unsuitable for these protected species. For example, newborn chicks that can't yet fly will starve if foraging habitat is unavailable, irrespective of how much nesting habitat is available. Therefore, the prohibition of ORV traffic in intertidal marsh areas is critical for the survival of these species.

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CONCLUSIONS

- Dates used at Fort Fisher State Recreation Area (FOFI) do not coincide with those used by the U.S. Fish and Wildlife Service, NC Wildlife Resources Commission, or US Army Corps of Engineers in management decisions affecting endangered, threatened, and significantly rare species, although dates used by the latter three agencies do agree—this creates confusion and ambiguity.

- The loggerhead sea turtle, listed federally as Threatened under the Endangered Species Act (ESA), regularly nests at FOFI in densities proportionate the length of park's beachfront nesting habitat, and the green sea turtle, listed as Endangered under the ESA, has nested both north (Masonboro Island) and south (Bald Head Island) of FOFI and likely nests at FOFI on rare occasions.

- Off-road vehicle (ORV) lights and tire ruts negatively affect nesting and hatchling sea turtles.

- Sea turtles nest approximately every two weeks, independent of the lunar cycle; therefore, the previous management decision to close FOFI for three nights around the full moon appeals to local legend but does not reflect the nesting biology of sea turtles.

- The Piping Plover, listed as Threatened under the ESA, uses FOFI at all times of the year; it is common during fall and spring migration, uncommon in the winter, and rare during the breeding season.

- FOFI is an important site (especially during the breeding season) for three species of shorebirds (Wilson's Plovers, American Oystercatchers, and Willets) that are considered to be Significantly Rare or of Special Concern; Wilson's Plovers and American Oystercatchers nest in undisturbed sparsely vegetated beachfront habitats, while Willets nest in undisturbed densely vegetated habitats; all three species utilize a variety of foraging and resting habitats.

- Colonial waterbirds (Least Terns, Common Terns, and Black Skimmers, all of which are considered to be species of Special Concern) seldom use FOFI, although each species uses other islands in this investigation; each species requires large tracts of undisturbed open to sparsely vegetated habitat in which to nest, which at FOFI has been designated for ORV traffic.

- ORV traffic in the beachfront and marsh intertidal areas compacts soil, thereby rendering it unsuitable for worms and other invertebrates used as forage by shorebirds and other consumers.

- Seabeach amaranth, a small fleshy annual plant that is listed federally as Threatened under the ESA, exists only in the Upper Beach Community, which at FOFI is open to ORV traffic that destroys young tender plants and prevents them from setting seed.

- The patchwork of open and closed areas in dune and marsh areas of FOFI effectively eliminates both as important foraging and resting habitat for migrating birds, which is noteworthy because FOFI serves as an important cross-over site during migration.

- FOFI is used throughout the year by at least one Endangered, Threatened, or Significantly Rare species; overall, however, more protected species are at FOFI during the spring and summer months, when the park's diverse assemblage of barrier beach habitats serve as critical breeding, foraging, and loafing habitat, and during the fall and spring months, when migrating shorebirds and colonial waterbirds utilize critical foraging, resting, and staging habitat.

- Personnel employed by federal and state agencies, including FOFI, are legislatively mandated to manage for the protection of Endangered, Threatened, and Significantly Rare species.

- ORV traffic disproportionately increases the amount of time that park personnel must devote to protected species management.

- Closing the entire beach throughout the year to ORV traffic is the only mechanism that would benefit all Endangered, Threatened, and Significantly Rare species at FOFI; allowing restricted ORV access does little to protect these species (i.e. any ORV traffic is too much traffic).

RECOMMENDATIONS

- Synchronize dates used in management decisions affecting endangered, threatened, and significantly rare species with dates used by other federal and state management agencies: 1 May-31 August for nesting sea turtles, continued throughout 15 November as necessary (sea turtle nests take about 66 days to hatch in southeastern North Carolina) and 1 April-31 August for nesting shorebirds and colonial waterbirds.

- There is no scientific basis to close FOFI to off-road vehicle (ORV) traffic for three nights around the full moon; terminate this restriction, regardless of other actions.

- However, because sea turtles nest continuously throughout the nesting season, *and* because ORV lights and tire ruts disorient and delay nesting and hatchling sea turtles, *and* because Piping Plovers use FOFI throughout the year, *and* because other protected shorebirds and colonial waterbirds also use FOFI, especially during the breeding season, *and* because seabeach amaranth only grows in the Upper Beach Community, either:

  Option 1—Suspend <u>all</u> ORV traffic from FOFI during the period from 1 April until 15 November (ORV traffic would continue to be allowed throughout FOFI during the period from 16 November to 31 March), *or*

  Option 2—Permanently prohibit <u>all</u> ORV traffic from the southernmost two miles of FOFI; institute a sea turtle nest relocation project and move all nests to this area; institute a habitat management policy that encourages mixed use by shorebirds, colonial waterbirds, and seabeach amaranth in this area (ORV traffic would continue to be allowed along the northernmost two miles throughout the year).

- Institute weekly shorebird and colonial waterbird surveys for three years to assess importance of FOFI for migrating, wintering, and nesting shorebirds and colonial waterbirds and to assess changing use patterns by shorebirds and colonial waterbirds after ORV traffic is limited; institute surveys every 2-3 days during the breeding season to determine if reproductive success for shorebirds and colonial waterbirds nesting at Fort Fisher State Recreation Area differs from that on adjacent beaches; and institute seabeach amaranth surveys 2-3 times each growing season (June through October) to assess re-colonization in ORV restricted areas.

- Develop and implement an outcomes assessment document such that, after a period of three years, all biological data can be assessed to determine if restrictions to ORV traffic have had a positive effect on protected species; revise ORV-use restrictions as warranted.

Table 1.—Survey results for nesting loggerhead sea turtles (# nests, if known) in southeastern North Carolina during the five-year period from 2000-2004. Surveys were conducted daily unless indicated otherwise.

Island area	2000	2001	2002	2003	2004
Figure Eight Island	yes (6)	yes (5)	yes (9)	yes (31)	yes (9)
Wrightsville Beach	yes (3)	yes (7)	yes (6)	yes (1)	yes (1)
Masonboro Island	yes (14)	yes (26)	yes (9+)[1]	yes[2] (1+)	yes[2] (1+)
Fort Fisher	yes (9)	yes (18)	yes (13)	yes (6)	yes (7)
Bald Head Island	yes (44)	yes (77)	yes (72)	yes (75)	yes (41)

[1] Surveys conducted every other day

[2] Regular monitoring suspended

Table 2.—Survey results for Piping Plover breeding pairs (# nests, if known), fall migrants, winter residents, and spring migrants in southeastern North Carolina during the five-year period from 2000-2004.

Island area	Year	Breeding pairs	Fall migrants	Winter residents	Spring migrants
Figure Eight Island	2000	no	yes	yes	yes
	2001	no	yes	yes	yes
	2002	no	yes	yes	yes
	2003	no	yes	yes	yes
	2004	yes[1]	yes	yes	yes
Wrightsville Beach	2000	no	yes	yes	yes
	2001	no	yes	yes	yes
	2002	no	yes	yes	yes
	2003	no	yes	yes	yes
	2004	no	yes	yes	yes
Masonboro Island	2000	no	no surveys	yes	no surveys
	2001	no	no surveys	yes	no surveys
	2002	no	no surveys	no surveys	no surveys
	2003	no[2]	no surveys	no surveys	no surveys
	2004	yes[3]	yes[2]	no surveys	no surveys
Fort Fisher	2000	no	no surveys	no surveys	no surveys
	2001	no	no surveys	yes	yes
	2002	yes (1)[2]	no surveys	yes	no surveys
	2003	no[2]	no surveys	no surveys	no surveys
	2004	yes[3]	no surveys	no surveys	no surveys
Bald Head Island	2000	no	yes	no surveys	no surveys
	2001	yes[3]	yes	no[2]	yes
	2002	no[2]	yes	no surveys	no surveys
	2003	no[2]	no surveys	no surveys	no surveys
	2004	no	no surveys	no surveys	no surveys

[1] Breeding pair observed; likely nested on Lea Island, the next island to the north

[2] Only one survey date in period

[3] Single individuals seen during breeding season, but no evidence of nesting

Table 3.—Survey results for breeding Wilson's Plovers, American Oystercatchers, and Willets (# nests, if known) in southeastern North Carolina during the five-year period from 2000-2004.

Island area	Year	Wilson's Plover	American Oystercatcher	Willet
Figure Eight Island	2000	yes	yes	yes
	2001	yes	yes	yes
	2002	yes (3)	yes (3)	yes (1)
	2003	yes (4)	yes (3)	yes
	2004	yes (5)	yes (5)	yes (3)
Wrightsville Beach	2000	no[1]	no[1]	yes
	2001	no[1]	no[1]	yes
	2002	yes (2)	yes (2)	yes
	2003	yes (7)	yes (5)	yes (4)
	2004	yes (10)	yes (4)	yes
Masonboro Island	2000	no	no	no
	2001	yes (8)	yes (20)	yes (13)
	2002	yes (10)	yes (16)	no
	2003	yes (12)[2]	no[2]	no[2]
	2004	yes (41)	yes (41)	yes (23)
Fort Fisher	2000	no	no	no
	2001	yes (22)	yes (12)	yes (23)
	2002	no[2]	no[2]	no[2]
	2003	no[2]	no[2]	no[2]
	2004	yes (9)[2]	yes (13)[2]	no[2]
Bald Head Island	2000	no	no	no
	2001	yes (9)	yes (1)	yes (11)
	2002	no[2]	no[2]	no[2]
	2003	no[2]	no[2]	no[2]
	2004	yes (6)	yes (2)	no

[1] Suitable habitat did not exist in the study area prior to the Mason Inlet Relocation Project

[2] Only one survey during the breeding season

Table 4.—Survey results for breeding Least Terns, Common Terns, and Black Skimmers (# nests, if known) in southeastern North Carolina during the five-year period from 2000-2004.

Island area	Year	Least Tern	Common Tern	Black Skimmer
Figure Eight Island	2000	yes	yes	yes
	2001	yes (50)	yes (20)	yes (40)
	2002	yes (5)	no[1]	no[1]
	2003	no	no[1]	no[1]
	2004	yes (12)	no[1]	no[1]
Wrightsville Beach	2000	no[2]	no[2]	no[2]
	2001	no[2]	no[2]	no[2]
	2002	no	no	yes (4)
	2003	yes	yes (2)	yes (166)
	2004	(202) yes (369)	yes (4)	yes (64)
Masonboro Island	2000	yes	no	no
	2001	yes	yes (3)	yes (41)
	2002	(99)	no	no
	2003	yes	no[3]	no[3]
	2004	(150) yes (115)[3] yes	no	no
Fort Fisher	2000	no	no	no
	2001	yes (3)[3]	no[3]	no[3]
	2002	no[3]	no[3]	no[3]
	2003	no[3]	no[3]	no[3]
	2004	no[3]	no[3]	no[3]
Bald Head Island	2000	no	no	no
	2001	no	no	no
	2002	no[3]	no[3]	no[3]
	2003	no[3]	no[3]	no[3]
	2004	no[3]	no[3]	no[3]

[1] Suitable habitat does not exist in the study area following the Mason Inlet Relocation Project

[2] Suitable habitat did not exist in the study area prior to the Mason Inlet Relocation Project

[3] Only one survey during the breeding season

III. Economic Impact Analysis

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Abstract

The North Carolina Legislature appropriated funds in the 2004/05 budget bill (2004 North Carolina House Bill 1414, Section 12.3(b)) to study vehicular access demand, associated biological effects, and potential economic impacts of vehicle access restriction at Fort Fisher State Recreation Area (FOFI), located in New Hanover county, North Carolina. This document presents results of an economic impact analysis of current vehicle trips to FOFI and possible vehicle access restrictions. The baseline number of annual beach vehicle trips, 28,884 trips/yr., supports an estimated $21.6 million in annual regional sales, 382 regional jobs, and $3.7 million in annual combined Federal, state and local tax revenue. Complete discontinuation of vehicular access to FOFI would result in the estimated loss of $11.0 million/yr. in regional sales, 191 regional jobs, and $1.9 million/yr. in tax revenues. A less restrictive policy allowing daytime-only vehicular access to FOFI would result in the estimated loss of $2.0 million/yr. in regional sales, 34 regional jobs, and $0.3 million/yr. in tax revenues. (These estimates include the economic impacts of those who currently make vehicular beach trips to FOFI and who would continue to make recreational beach trips to the local area even without vehicle access to FOFI.)

Introduction

Ocean beach vehicular access has been a controversy at Fort Fisher State Recreation Area (FOFI) in New Hanover County, North Carolina, for a number of years. Concerns have been voiced by local beach fishermen and residents who wish to have vehicle access to the site at all times. Other site users and park staff feel that protection of Federal/state listed species (e.g., nesting loggerhead sea turtle and water birds) from vehicular impacts on the oceanfront and staffing limitations during evening hours require a more limited access schedule typical of other state park properties. To provide additional information to help resolve the issue, the North Carolina Legislature appropriated funds in the 2004/05 budget bill (2004 North Carolina House Bill 1414, Section 12.3(b)) to study FOFI vehicular access demand, associated biological effects, and potential economic impacts of vehicle access restriction.

This document has been prepared in partial fulfillment of a contract to the University of North Carolina Wilmington (UNCW) for an Ocean Beach Vehicular Access Study at FOFI located near Kure Beach, North Carolina. The study was conducted by UNC-Wilmington faculty between August 15, 2004 and December 31, 2004. This document presents results of an economic impact analysis of current vehicle trips to FOFI and possible vehicle access restrictions. Companion UNCW reports present results concerning FOFI vehicular access demand and associated biological effects.

Scope of Work

Economic Impact Analysis: Dr. Chris Dumas will perform an economic impact analysis of restricting 24-hour access. This will be achieved by using data from the demand analysis described in the companion report by Drs. Robert Buerger, Jim Herstine and Jeffery Hill of UNC-Wilmington and relevant literature to develop a model that will compare valuations of different use scenarios.

Deliverables

An economic impact analysis comparing 24-hour vehicular ocean beach access to: 1. daytime-only access, 2. going to another 24-hour vehicular-accessible beach, or 3. complete discontinuation of vehicular beach access. However, because only 2 of 120 survey respondents indicated that they would travel to beaches outside New Hanover county if vehicular access to FOFI beaches were restricted, item 2 was judged insignificant, and the present report focuses on items 1 and 3.

Methods

Input-output analysis is used to estimate economic impacts. Input-output analysis is an economic modeling methodology used to estimate the full economic impacts of a given, initial change in spending in a regional economy. Input-output analysis tracks the flow of dollars between and among businesses, consumers, workers, and government agencies in a study region. See Miller and Blair (1985) for additional information on input-output analysis.

IMPLAN Professional® Input-Output Analysis computer software (Minnesota IMPLAN Group, Inc. 1999) is used in this study to conduct input-output analysis. IMPLAN Pro is a leading input-output modeling software package used by university researchers, government agencies, and consultants nationwide. The IMPLAN software tracks 525 commercial and industry sectors, and local, state and Federal government sectors, on a county-by-county basis.

Input-output analysis requires a defined study region. The study region for this project is defined as New Hanover County, North Carolina. Although the direct economic impacts considered in this study will occur largely in the Ft. Fisher/Kure Beach/Carolina Beach portion of the county, this portion of the county is tied economically to New Hanover county as a whole, especially the city of Wilmington. A full assessment of economic impacts requires that the county as a whole be considered in the analysis.

Input-output analysis requires two types of data: baseline industry structure data, and data describing the initial, “direct” economic impacts. Industry structure data describe the input purchases (materials, energy, employee labor, etc.) that must be made by each industry in order to produce its product. Industry structure data for 1999 were obtained from Minnesota IMPLAN Group, Inc. as part of the database accompanying the IMPLAN analysis software (i.e., the 1999 IMPLAN structural matrix was used in the analysis). Minnesota IMPLAN Group, Inc., constructs the industry structure database from government surveys of businesses and consumers. Data on the initial, "direct" economic impacts are derived from the survey data collected as part of the present study (see Table 2 below).

Economic impact results are presented in terms of: (1) changes in New Hanover county employment, (2) changes in annual business sales by industry sector, and (3) changes in the primary components of annual tax receipts at the Federal, state and local level. The reported impacts on employment and sales have three components: (1) initial, "direct" impacts, (2) indirect, “ripple” effects on supplying businesses, and (3) induced, household-spending “feedback” effects. Components (2) and (3) together are sometimes called "economic multiplier effects." Employment impacts include both full-time and part-time jobs (the data are not sufficient to distinguish full-time from part-time jobs). The reported tax impacts include all multiplier effects.

The economic impact analysis compares three management scenarios. The first scenario is the "baseline" scenario. Under the baseline scenario, the existing beach access fee at FOFI is assumed to be in place, but there are no additional restrictions on vehicle access. The second scenario, "complete discontinuation of vehicle access," prohibits all vehicle access to FOFI. The third scenario, “daytime-only vehicle access,” prohibits vehicle access to FOFI at night but allows daytime access. Under all scenarios, pedestrian access to FOFI is allowed. The scenarios differ from one another in terms of the number of vehicle beach trips to FOFI. Survey data (described below) are used to determine the regional economic impact per vehicle trip, and economic impacts across scenarios differ according to differences in the number of vehicle beach trips across scenarios. Allowance is made for the economic impact of those who would continue to make recreational beach trips to the local area even without vehicle access to FOFI.

Survey Data

The companion report "Ocean Beach Vehicular Access Study at Fort Fisher State Recreation Area," authored by Drs. Robert Buerger, Jim Herstine and Jeffery Hill of UNC-Wilmington, describes the research methodology used to collect the survey data analyzed in this report. Two types of data were collected: (1) electronic counts of vehicles entering FOFI and (2) spot surveys administered to individuals in vehicles entering FOFI. During the July 2nd through December 15th time period, the electronic counter recorded 15,883 vehicles passing through the FOFI ocean beach vehicular access entrance. A total of 181 spot surveys were administered to vehicles entering FOFI between September 15th and December 15th to collect information on park use, visitor demographics, and economics. Of the 181 spot surveys, 127 were valid surveys, for a survey response rate of over 71%. Of the 127 valid surveys, 120 provided full monetary expenditure data, and 117 provided data on substitute recreational activities (i.e., alternative recreational activities that would be pursued if vehicle access were restricted).

Estimated Number of Beach Vehicle Trips

We have actual vehicle trip count data for both day and night for the fall/winter 2004 season. We have survey respondent *estimates* of their day and night vehicle trips for both the fall/winter 2004 season and the spring/summer 2004 season.

The vehicle count data indicate that approximately 25% of beach vehicle trips were night trips during the fall/winter 2004 season (September 15 through December 15). Survey respondents *estimated* that approximately 33% of beach vehicle trips were night trips during the fall/winter 2004 season. Several possibilities may account for the differences between the vehicle count night trip percentage estimate and the survey data night trip percentage estimate: (1) the survey may not be a perfectly random (representative) sample of the vehicle trip population, and/or (2) survey respondents may be either under-estimating day trips, over-estimating night trips, or some combination of both.

For the purposes of this study, we use an estimate of 8,500 vehicle trips made during the 92 fall/winter days from September 15 through December 15, 2004. This figure is based on the actual vehicle count data. We define the fall/winter season as September 15 through March 15 (approximately 183 days). To estimate the number of vehicle trips occurring from December 16 through March 15, the colder portion of the season, we use the average number of vehicle trips per day in the colder sampled months, November and December, or 32 trips per day, multiplied by 91 days, or 2,912 trips. Adding 8,500 trips and 2,912 trips yields an estimate of **11,412 vehicle trips per fall/winter season** (September 15 through March 15). Assuming that 25% of these trips are night trips (based on the actual vehicle count data) produces an estimate of **2,853 *night* trips per fall/winter season**.

We define the spring/summer season as March 16 through September 14 (approximately 182 days). The 120 survey respondents who provided expenditure data estimate that they take 2,184 vehicle trips in the spring/summer season vs. 2,264 vehicle trips in the fall/winter season, or 0.96 spring/summer trip per fall/winter trip. Multiplying the estimate of the number of fall/winter trips (11,412) by 0.96 spring/summer trip per fall/winter trip produces an estimate of 10,956 vehicle trips per spring/summer season. This estimate is equivalent to an average number of trips per day of 10,956 trips / 182 days = 60 trips/day during the spring/summer season.

However, this estimate may underestimate the number of trips if the population of spring/summer beach trippers is different from the population of fall/winter beach trippers, and the spring/summer population takes a larger number of spring/summer beach trips per day relative to the fall/winter population (e.g., there may be sample selection bias that biases downward the estimate of spring/summer trips per day). In support of this possibility, partial vehicle count data for a portion of the spring/summer season (from July 2 through August 31, 2004) indicate an average of 131 vehicles/day during this portion of the spring/summer season. On the other hand, the colder March-May months of the spring/summer season may have vehicle counts much lower than the 131 vehicles/day value. In the absence of better data, we take the average of the 60 trips/day and 131 trips/day values to produce an average estimate of 96 trips/day in the spring/summer season. Multiplying 96 trips/day by 182 days in the spring/summer season produces a final estimate of **17,472 vehicle trips per spring/summer season**.

Survey respondents estimated that 12.9% of their spring/summer trips were night trips. Unfortunately, the partial vehicle count data available for July 2 through August 31, 2004 do not distinguish between day trips and night trips, so there is no estimate of the percentage of night trips based on vehicle count data with which to compare the 12.9% survey estimate. In the absence of additional data, we multiply the estimated 17,472 vehicle trips per spring/summer season by the survey estimate of the percentage of night trips, or 12.9%, to produce an estimate of **2,253 *night* vehicle trips per spring/summer season**.

Estimated Monetary Expenditures per Beach Vehicle Trip

The final sample of survey respondents provided full monetary expenditure data for 120 vehicle trips (total day and night trips combined) from September 15 to December 15. The number of people per vehicle ranged from 1 to 5, with a median of 2 and a mean of 2.12. Expenditures per expenditure category on a per person basis and total expenditures for all 120 vehicle trips providing full expenditure data are presented in Table 1.

Baseline Economic Activity Supported by Beach Vehicle Trip Expenditures

The "baseline" scenario is defined as the estimated total number of vehicle trips occurring per year in the absence of beach access closure but with existing beach access fees in place. The baseline number of beach vehicle trips per year is the sum of estimated fall/winter season trips (11,412 vehicle trips) and spring/summer season trips (17,472 vehicle trips), for a total of 28,884 trips. Each baseline scenario beach vehicle trip is assumed to result in direct monetary expenditures as presented in the right-most column of Table 1. Multiplying each of these per vehicle trip expenditure values by 28,884 trips per year produces estimates of total annual direct expenditures under the baseline scenario as presented in Table 2.

The regional economic activity supported by the annual, baseline, direct expenditures presented in Table 2 is estimated using a regional economic input-output model (as described above). Model estimates are presented (Tables 3, 4, and 5) in the Results section below.

Estimated Economic Impact of Complete Discontinuation of Vehicular Access

To examine the economic impact of complete discontinuation of vehicular access to the Ft. Fisher State Recreation Area, we eliminate all vehicle access trips. However, when these trips are eliminated, some beachgoers will continue to make beach trips that do not require vehicular beach access, whereas others will choose to stay at home and forego beach trips altogether. Those who continue to make beach trips to/within the local area continue to make expenditures that support the local area economy, whereas those who stay home withdraw their expenditures from the local area economy.

Of the 120 survey respondents who provided monetary expenditure data, 117 provided data on substitute recreational activities. That is, 117 respondents provided an answer to the survey question, "If this beach had been closed today/tonight, what would you have done instead?" Of the 117 answers to this question, 42 (or 36%) indicated that the survey respondent would have stayed home and taken no beach trip of any kind, 61 (or 52%) indicated that the respondent would have gone to the north end of Carolina Beach or would have engaged in a non-vehicular beach activity in either the Ft. Fisher area or elsewhere in the Carolina/Kure Beach area, and 14 (or 12%) indicated that the respondent would have gone to another beach outside the Carolina/Kure Beach area. Based on these survey results, we estimate that complete discontinuation of vehicular access at Ft. Fisher State Recreation Area would result in a 48% (36% plus 12%) reduction in beach trips to the Carolina/Kure Beach area that formerly made use of vehicle access, while 52% of the former vehicle access beach trips would continue to be made in the Carolina/Kure beach area, but these trips would be made without driving vehicles on the beach. Such trips would include, for example, beach trips where vehicles are parked in public lots or parking spaces, trips to fishing piers, and trips to the Ft. Fisher aquarium (note: these activities were mentioned by survey respondents). In cases where beach trips

continue to occur (but without driving vehicles on the beach), we assume that trip expenditures remain the same, except that gasoline expenditures are reduced by 25%.

The annual, regional economic impacts of complete discontinuation of vehicular access to Ft. Fisher State Recreation Area are estimated using a regional economic input-output model (as described above). Model estimates are presented (Tables 6, 7, and 8) in the Results section below.

Estimated Economic Impact of Daytime-Only Vehicular Access

To examine the economic impact of allowing daytime-only vehicular access to Ft. Fisher State Recreation Area, we eliminate night vehicle trips only. When these night trips are eliminated, some nighttime beachgoers will continue to make night beach trips that do not require vehicular beach access, whereas others will choose to stay home and forego beach trips altogether. Using the data on substitute trip activities described in the section above, we estimate that 48% of the individuals formerly making night vehicle trips would choose to stay home and make no trip, whereas 52% of the individuals formerly making night vehicle trips would continue to make beach trips to the Carolina/Kure beach area that would not involve driving vehicles on the beach (for example, night pier fishing trips, night walks on the beach, night kayak/canoe trips, etc.).

The annual, regional economic impacts of allowing daytime-only vehicular access to Ft. Fisher State Recreation Area are estimated using a regional economic input-output model (as described above). Model estimates are presented (Tables 9, 10, and 11) in the Results section below.

Results

Baseline Economic Activity Supported by Beach Vehicle Trip Expenditures

Table 3 presents the regional sales activity supported by the baseline annual direct expenditures presented in Table 2. The first column of Table 3 presents the direct economic impacts, which are simply the baseline expenditures from Table 2. The second column of Table 3 gives the indirect economic impacts, or economic "ripple effects," of the direct economic impacts on supplying industries in the region. The third column of Table 3 gives the induced economic impacts, the "feedback effects" of the direct and indirect impacts on subsequent spending by the employees and owners of the businesses affected by the direct and indirect impacts. Together, the indirect and induced impacts measure the economic "multiplier effect." Finally, the fourth column of Table 3 gives the total economic impact of baseline expenditures, the combined direct, indirect and induced impacts. The totals at the bottom of Table 3 indicate that $11,223,168/yr. of estimated baseline direct expenditures produce an estimated $1,903,489/yr. in indirect impacts and $8,543,064/yr. in induced impacts,

for an estimated total economic impact of $21,669,721/yr. This value is an estimate of the regional sales activity supported by the baseline annual direct expenditures presented in Table 2, before any restrictions occur on beach vehicle trips.

Table 4 presents estimates of the regional employment supported by the baseline annual direct expenditures presented in Table 2. The first column of Table 4 presents the direct employment impacts, the jobs supported directly by the baseline expenditures from Table 2. The second column of Table 4 gives the indirect employment impacts, the "ripple effect" of baseline expenditures on employment in supplying industries. The third column of Table 4 gives the induced employment impacts, the "feedback effects" of baseline expenditures on employment due to the spending of employees and owners of the businesses affected by the direct and indirect impacts. Together, the indirect and induced employment impacts measure the economic "multiplier effect" on employment. Finally, the fourth column of Table 4 gives the total employment impact, the total of the direct, indirect and induced employment impacts. The totals at the bottom of Table 4 indicate that an estimated 245 jobs are supported by baseline direct expenditures, with an additional 137 jobs supported by the indirect and induced multiplier effects, for an estimated total of 382 jobs supported in the study region of New Hanover County, NC.

Table 5 presents estimates of the tax revenues received by Federal, state, and local governments as a result of the total economic impacts presented in Table 3. Estimated Federal personal income tax revenues are $772,395/yr., Federal corporate profit taxes are $277,104/yr., and Federal payroll taxes are $1,036,237/yr. Estimated North Carolina state personal income tax revenues are $242,166/yr., state corporate profit taxes are $51,765/yr., and state payroll taxes are $11,795/yr. Local business property taxes are $487,122/yr., and combined state and local sales taxes are $866,101/yr. Total tax revenues accruing to all levels of government are an estimated $3,744,686/yr.

Estimated Economic Impact of Complete Discontinuation of Vehicular Access

Table 6 presents estimates of the impact of a complete discontinuation of vehicular access at Ft. Fisher on regional sales activity. The first column of Table 6 indicates that direct sales fall by an estimated $5,699,944/yr. with complete discontinuation of vehicular access. Direct sales do not fall by the full $11,223,168/yr. of baseline direct sales because, as described above, a significant number of recreational beach trips to Ft. Fisher/Kure Beach/Carolina Beach continue to occur under discontinuation of vehicular beach access, although these trips do not include driving on the beach as part of the experience. The second and third columns of Table 6 give the indirect and induced economic multiplier effects on regional sales activity resulting from the initial drop in direct sales. These multiplier effects total -$5,320,184. Finally, the fourth column of Table 6 gives the estimated total economic impact of a complete discontinuation of vehicular access on regional sales activity: -$11,020,127/yr.

Table 7 presents estimates of the impact of a complete discontinuation of vehicular access at Ft. Fisher on regional employment. The first column of Table 7 indicates that direct employment falls by an estimated 121 jobs under complete discontinuation of vehicular access. The second and third columns of Table 7 give the indirect and induced economic multiplier effects on regional employment. These multiplier effects result in an additional 70 jobs lost. Finally, the fourth column of Table 7 gives the estimated total economic impact of a complete discontinuation of vehicular access on regional employment: 191 jobs lost in the study region of New Hanover County, NC.

Table 8 presents estimates of the tax revenues lost by Federal, state, and local governments as a result of a complete discontinuation of vehicular access at Ft. Fisher. Federal personal income tax revenues fall by an estimated $393,405/yr., Federal corporate profit taxes fall $141,298/yr., and Federal payroll taxes fall $526,719/yr. North Carolina state personal income tax revenues fall $123,336/yr., state corporate profit taxes fall $26,369/yr., and state payroll taxes fall $5,996/yr. Local government property taxes fall $251,025/yr., and local sales taxes fall $446,322/yr. Total tax revenues accruing to all levels of government fall by an estimated $1,914,497/yr.

Estimated Economic Impact of Daytime-Only Vehicular Access

Table 9 presents estimates of the impacts of allowing daytime-only vehicular access at Ft. Fisher on regional sales activity. The first column of Table 9 indicates that direct sales fall by an estimated $1,009,314/yr. under daytime-only vehicular access. Direct sales do not fall by the full $11,223,168/yr. of baseline direct sales because daytime vehicular trips continue to be made, and a significant proportion of night recreational beach trips (pier fishing, etc.) continue to occur, although these night trips do not include driving on the beach. The second and third columns of Table 9 give the indirect and induced economic multiplier effects on regional sales activity. Together, these multiplier effects total -$942,067/yr. Finally, the fourth column of Table 9 gives the estimated total impact on regional sales activity of allowing daytime-only vehicular access: -$1,951,381/yr.

Table 10 presents estimates of the impacts of allowing daytime-only vehicular access at Ft. Fisher on regional employment. The first column of Table 10 indicates that direct employment falls by an estimated 22 jobs under daytime-only vehicular access. The second and third columns of Table 10 give the indirect and induced economic multiplier effects on regional employment. These multiplier effects result in an additional 12 jobs lost. Finally, the fourth column of Table 10 gives the estimated total economic impact of daytime-only vehicular access on regional employment: 34 jobs lost in the study region of New Hanover County, NC.

Table 11 presents estimates of the tax revenues lost by Federal, state, and local governments as a result of daytime-only vehicular access at Ft. Fisher. Federal personal income tax revenues fall by an estimated $69,662/yr., Federal corporate

profit taxes fall $25,020/yr., and Federal payroll taxes fall $93,268/yr. North Carolina state personal income tax revenues fall $21,839/yr., state corporate profit taxes fall $4,674/yr., and state payroll taxes fall $1,062/yr. Local government property taxes fall $44,449/yr., and local sales taxes fall $79,032/yr. Total tax revenues accruing to all levels of government fall by an estimated $339,007/yr.

Conclusions and Discussion

This document presents the results of an economic impact analysis of recreational vehicle trips to the beach located in Fort Fisher State Recreation Area (FOFI), New Hanover county, North Carolina, and possible restrictions to vehicular beach access. The estimated baseline number of annual beach vehicle trips, 28,884 trips/yr. in 2004, supports an estimated $21.6 million (2004 $'s) in annual regional sales, 382 regional jobs, and $3.7 million in annual combined Federal, state and local tax revenue. Complete discontinuation of vehicular access to FOFI would result in the estimated loss of $11.0 million/yr. in regional sales, 191 regional jobs, and $1.9 million/yr. in tax revenues. A less restrictive policy allowing daytime-only vehicular access to FOFI would result in the estimated loss of $2.0 million/yr. in regional sales, 34 regional jobs, and $0.3 million/yr. in tax revenues. (Note: These estimates include the economic impacts of individuals who currently make vehicular beach trips to FOFI and who would continue to make recreational beach trips to the local area even without vehicle access to FOFI.)

The economic impact results reported here should be interpreted as tentative results based on limited data. A limited project budget and accelerated timeline restricted the data collection effort to September 15--December 15, 2004. Given that the survey responses were only generated from users who came to the ocean beach at FOFI during the early fall through winter months, the question arises of whether the sample truly represents the population of FOFI users throughout the year. Individuals who use the ocean beach at FOFI exclusively during the spring and summer months were not included in the sample pool. However, fall and winter survey respondents were asked questions about their spring and summer beach trip behavior, and estimates of spring and summer beach trip activity and associated economic impacts were made based on their responses. Still, the number of spring and summer vehicular beach trips, the magnitude of associated total expenditures, and the distribution of expenditures across types of goods and services may differ for the spring and summer season.

Other aspects of the survey data may impart some bias to the economic impact results (although some biases working in opposite directions likely counter-act one another to some extent). First, although survey respondents were asked for expenditure values on a per person basis, some respondents may have provided expenditure values for the entire group of persons in the vehicle rather than the requested per person values. To the extent that this occurred, the true economic impacts of vehicular restrictions would be somewhat smaller than those reported

here, because the reported values were multiplied by the number of persons in each vehicle.

Second, survey respondents were asked to report monetary expenditure data on a "per vehicle beach trip" basis. However, some survey respondents may not have listened carefully to survey questions and may have provided expenditure values on a "per spending occasion" basis, instead. For example, respondents may have answered that they typically spend $25 per person per visit to a restaurant in Carolina Beach, whether or not they actually visit a restaurant on *every* vehicle beach trip. To the extent that expenditures were mistakenly reported by survey respondents on a "per spending occasion basis," the true economic impacts of vehicular restrictions would be somewhat smaller than those reported here.

Third, if vehicular beach access were restricted, some survey respondents indicated that they would stay at home and make no trips to the beach, while others indicated that they would make non-vehicular trips to the beach or engage in some other type of recreational activity. Although the results presented in this report reflect best estimates of the regional economic impacts of changes in the number and types of beach trips, the results do not capture the full change in economic value accruing to the recreationists themselves. For example, suppose an individual who formerly took a vehicular beach trip decides to take a non-vehicular trip to the beach after vehicle access is discontinued, and suppose further that the individual spends exactly the same amount of money on exactly the same items. While there would be no recorded economic impact on the region (because the individual's expenditures remain the same), the individual herself might very well suffer a reduction in *personal satisfaction* from the trip if she *enjoyed* a vehicle beach trip more than a non-vehicle beach trip. Economists term the economic value of such lost satisfaction "consumer surplus." Due to budget and timeline limitations, the present study makes no attempt to measure consumer surplus. To the extent that consumer surplus is significant, the true economic impacts of vehicular restrictions would be somewhat larger than those reported here. (Note: Methods exist to estimate consumer surplus values based on the analysis of appropriate survey data.)

Fourth, those survey respondents who indicated that they would "stay home" if vehicular beach access were discontinued may still spend some money on substitute activities, such as ordering pizza for home delivery, renting VCR movies, etc. However, the impact estimates presented in this report assume that the individuals who choose to "stay home" would fully withdraw the money they would have spent on a vehicular beach trip from the regional economy. To the extent that those who choose to remain "home alone" make unreported expenditures, the true economic impacts of vehicular restrictions would be somewhat smaller than those reported here.

Fifth, the economic impact estimates presented here assume no other changes in regional beach access policy. This caveat is especially important when trying to estimate the economic impacts of substitute activities under a vehicular access

closure at FOFI. For example, consider the 61 survey respondents (out of the 120 who provided full monetary expenditure data) who said that they would continue to make a beach trip to the study region even if vehicular access to FOFI were restricted. Of these 61 respondents, 38 indicated that they would go to the "North End" area of Carolina Beach, an area where vehicular beach access is currently allowed. If vehicle access to the North End of Carolina Beach were to be restricted, then the economic impacts of vehicular restrictions at FOFI would likely be somewhat larger than those reported here. The point here is that the economic impacts of a change in vehicle access policy at FOFI depend on the beach access policies in place at nearby, substitute beaches.

References

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Table 1. Beach Vehicle Trip Expenditure Data Summary

Expenditure Category	Mean[1] Expenditures Per person Per vehicle trip	Median[2] Expenditures Per person Per vehicle trip	Total Expenditures[3] By All Persons In All 120 Surveyed Vehicle Trips	Mean Expenditures Per Surveyed Vehicle Trip[4]
Hotel/Motel	$38.14	$00.00	$10,283.00	$85.69
Restaurants/Bars	$45.76	$17.50	$11,685.00	$97.38
Other Food and Beverage (Groceries)	$26.41	$10.00	$6,634.00	$55.28
Fishing and Beach Supplies	$32.82	$15.00	$8,028.00	$66.90
Gasoline	$41.20	$30.00	$9,997.20	$83.31

Table 1. notes:
[1] For each expenditure category, mean expenditure is the mathematical average expenditure per person in the sample.
[2] Median expenditures reflect *typical* expenditures per person in the sample. That is, for each expenditure category, fifty percent of the sampled individuals reported values higher than the median, and fifty percent reported values lower than the median. Compared with mean values, median values are less influenced by unusually large or small values in the sample.
[3] Total expenditures are derived by multiplying the expenditure values per person in each vehicle by the number of people in the vehicle and then adding the resulting values across all vehicles in the sample.
[4] For each expenditure category, mean expenditures per surveyed vehicle trip are calculated by dividing the total expenditures of all persons in all 120 surveyed vehicles by 120 vehicle trips.

Table 2. Baseline Scenario Annual Direct Expenditures

Expenditure Category	Annual Direct Expenditures Under Baseline Scenario (28,884 vehicle trips/yr)
Hotel/Motel	$2,475,118
Restaurants/Bars	$2,812,580
Other Food and Beverage (Groceries)	$1,596,804
Fishing and Beach Supplies	$1,932,340
Gasoline	$2,406,326
Totals	$11,223,168

Table 3. Baseline Scenario--Sales (Output) Supported by Baseline FOFI Beach Vehicle Trips

Industry	Direct Sales Supported (2004 Dollars)	Indirect Sales Supported (2004 Dollars)	Induced Sales Supported (2004 Dollars)	Total Sales Supported (2004 Dollars)
Advertising	$0	$12,268	$3,888	$16,156
Agri, Forestry, Lumber, Pulp & Paper	$0	$20,066	$23,388	$43,453
Banking, Financial, Accounting Services	$0	$239,935	$381,953	$621,888
Child Day Care	$0	$0	$33,929	$33,929
Commercial Fishing	$0	$2,708	$412	$3,120
Construction	$0	$144,761	$1,516,878	$1,661,639
Education: Schools, Colleges, Universities	$0	$480	$812,613	$813,093
Govt: Federal, incl Military	$0	$27,401	$226,076	$253,478
Govt: State & local, non-educ	$0	$1,784	$517,480	$519,264
Hospitals, Doctors, Dentists	$0	$9	$493,722	$493,731
Hotels and Lodging Places	$2,475,118	$29,495	$73,704	$2,578,318
Household Cleaning Services	$0	$0	$15,530	$15,530
Insurance	$0	$3,352	$68,400	$71,752
Landscaping, Horticulture, Greenhouses	$0	$14,283	$26,287	$40,570
Legal Services	$0	$23,720	$77,094	$100,814
Manf: Boat Building & Repair	$0	$1	$78	$79
Manf: Clothing, Shoes, Leather Goods Manf	$0	$1,350	$30,739	$32,089
Manf: Concrete, Cement, Brick	$0	$5	$70	$75
Manf: Food processing	$0	$6,384	$9,494	$15,878
Manf: Furniture & Wood Products	$0	$1,346	$15,454	$16,800
Manf: Newspapers	$0	$23,387	$9,563	$32,950
Manf: Other	$0	$20,474	$123,505	$143,979
Manf: Petroleum, Chemicals, & Mining	$0	$25,946	$206,842	$232,788
Manf: Printing and publishing	$0	$18,515	$11,744	$30,259
Non-profit organizations	$0	$3,240	$76,130	$79,369
Other Business Services	$0	$294,972	$293,323	$588,295
Real estate	$0	$300,086	$894,493	$1,194,579
Recreation: Bowling Alleys & Pool Halls	$0	$4	$1,773	$1,777
Recreation: Golf and Amateur Team Sports	$0	$1,460	$16,344	$17,804
Recreation: Movie Theaters	$0	$28,922	$43,639	$72,561
Recreation: Other Amusement Facilities	$0	$9,171	$64,307	$73,478
Retail: Auto Parking & Car Wash	$0	$1,722	$11,429	$13,150
Retail: Auto Rental	$0	$12,775	$26,155	$38,930
Retail: Auto Repair & Service	$0	$17,558	$72,450	$90,008
Retail: Automobile Sales & Service	$2,406,326	$8,911	$212,649	$2,627,887
Retail: Beauty and Barber Shops	$0	$0	$19,387	$19,387
Retail: Clothing & Shoes	$0	$868	$55,254	$56,122
Retail: Department Stores	$1,932,340	$1,208	$118,314	$2,051,863
Retail: Equipment Rental	$0	$7,434	$15,734	$23,168

Retail: Furniture	$0	$1,371	$73,379	$74,750
Retail: Grocery Stores	$1,596,804	$1,331	$137,407	$1,735,542
Retail: Home Improvement Stores	$0	$2,358	$62,823	$65,181
Retail: Laundry Services	$0	$16,369	$23,314	$39,683
Retail: Miscellaneous	$0	$17,553	$279,793	$297,347
Retail: Photographic Studios	$0	$10,657	$12,413	$23,070
Retail: Restaurants	$2,812,580	$33,619	$298,964	$3,145,163
Retail: Travel Agencies	$0	$12,927	$2,485	$15,412
Retirement Homes & Elder-Care	$0	$0	$28,925	$28,925
Transport: Air Transportation	$0	$7,046	$22,629	$29,675
Transport: Bus Services	$0	$1,095	$8,393	$9,488
Transport: Seaport & Water Transp.	$0	$2,605	$18,359	$20,965
Transport: Trucking	$0	$62,255	$115,510	$177,766
TV, Radio, Other Comm Services	$0	$158,158	$174,178	$332,336
Utilities: Electricity & Nat. Gas	$0	$82,174	$152,470	$234,644
Utilities: Water, Sewer, Trash Services	$0	$49,565	$97,005	$146,570
Wholesale, Warehousing & Distribution	$0	$138,404	$434,792	$573,196
Total	$11,223,168	$1,903,489	$8,543,064	$21,669,721

Table 4. Baseline Scenario--Employment Supported by Baseline FOFI Beach Vehicle Trips

Industry	Direct Employment Supported (Jobs)	Indirect Employment Supported (Jobs)	Induced Employment Supported (Jobs)	Total Employment Supported (Jobs)
Advertising	0.0	0.2	0.1	0.2
Agri, Forestry, Lumber, Pulp & Paper	0.0	0.1	0.1	0.2
Banking, Financial, Accounting Services	0.0	2.5	2.9	5.4
Child Day Care	0.0	0.0	0.7	0.7
Commercial Fishing	0.0	0.2	0.0	0.2
Construction	0.0	2.0	11.9	13.9
Education: Schools, Colleges, Universities	0.0	0.0	20.6	20.6
Govt: Federal, incl Military	0.0	0.3	3.6	4.0
Govt: State & local, non-educ	0.0	0.0	8.6	8.6
Hospitals, Doctors, Dentists	0.0	0.0	6.6	6.6
Hotels and Lodging Places	48.4	0.6	1.4	50.4
Household Cleaning Services	0.0	0.0	1.5	1.5
Insurance	0.0	0.0	0.6	0.6
Landscaping, Horticulture, Greenhouses	0.0	0.4	0.6	1.0
Legal Services	0.0	0.3	1.0	1.3
Manf: Boat Building & Repair	0.0	0.0	0.0	0.0
Manf: Clothing, Shoes, Leather Goods Manf	0.0	0.0	0.3	0.3
Manf: Concrete, Cement, Brick	0.0	0.0	0.0	0.0
Manf: Food processing	0.0	0.0	0.0	0.1
Manf: Furniture & Wood Products	0.0	0.0	0.2	0.2
Manf: Newspapers	0.0	0.3	0.1	0.4
Manf: Other	0.0	0.1	0.6	0.7
Manf: Petroleum, Chemicals, & Mining	0.0	0.1	0.6	0.6
Manf: Printing and publishing	0.0	0.2	0.1	0.2
Non-profit organizations	0.0	0.1	2.2	2.3
Other Business Services	0.0	6.0	4.9	10.9
Real estate	0.0	1.9	2.4	4.3
Recreation: Bowling Alleys & Pool Halls	0.0	0.0	0.1	0.1
Recreation: Golf and Amateur Team Sports	0.0	0.0	0.5	0.5
Recreation: Movie Theaters	0.0	0.3	0.5	0.8
Recreation: Other Amusement Facilities	0.0	0.1	2.3	2.3
Retail: Auto Parking & Car Wash	0.0	0.1	0.5	0.5
Retail: Auto Rental	0.0	0.1	0.3	0.4
Retail: Auto Repair & Service	0.0	0.2	0.8	1.0
Retail: Automobile Sales & Service	27.9	0.1	2.5	30.5
Retail: Beauty and Barber Shops	0.0	0.0	0.8	0.8
Retail: Clothing & Shoes	0.0	0.0	1.6	1.6
Retail: Department Stores	46.2	0.0	2.8	49.1
Retail: Equipment Rental	0.0	0.1	0.1	0.2
Retail: Furniture	0.0	0.0	0.9	0.9
Retail: Grocery Stores	47.2	0.0	4.1	51.3
Retail: Home Improvement Stores	0.0	0.0	1.1	1.1
Retail: Laundry Services	0.0	0.7	1.0	1.6
Retail: Miscellaneous	0.0	0.3	7.2	7.5
Retail: Photographic Studios	0.0	0.1	0.2	0.3
Retail: Restaurants	75.1	0.9	8.0	84.0
Retail: Travel Agencies	0.0	0.3	0.1	0.4
Retirement Homes & Elder-Care	0.0	0.0	0.9	0.9
Transport: Air Transportation	0.0	0.1	0.2	0.3
Transport: Bus Services	0.0	0.0	0.2	0.2
Transport: Seaport & Water Transp.	0.0	0.0	0.1	0.1
Transport: Trucking	0.0	0.5	1.0	1.5
TV, Radio, Other Comm Services	0.0	0.9	0.8	1.7
Utilities: Electricity & Nat. Gas	0.0	0.2	0.3	0.5
Utilities: Water, Sewer, Trash Services	0.0	0.3	0.5	0.7
Wholesale, Warehousing & Distribution	0.0	1.3	4.1	5.4
Total	244.8	21.9	115.0	381.7

Table 5. Baseline Scenario--Tax Revenue Supported by Baseline FOFI Beach Vehicle Trips

Tax Type	Baseline Taxes Supported (2004 Dollars)
Federal Personal Income Taxes	$772,395
Federal Corporate Profits Taxes	$277,104
Federal Payroll Taxes	$1,036,237
State Personal Income Taxes	$242,166
State Corporate Profits Taxes	$51,765
State Payroll Taxes	$11,795
Local Business Property Taxes	$487,122
State & Local Sales Taxes	$866,101
Total	$3,744,686

Table 6. Complete Discontinuation of Vehicle Access Scenario--Impacts on Regional Sales (Output)

Industry	Direct Sales Impacts (2004 Dollars)	Indirect Sales Impacts (2004 Dollars)	Induced Sales Impacts (2004 Dollars)	Total Sales Impacts (2004 Dollars)
Advertising	$0	-$6,372	-$1,982	-$8,354
Agri, Forestry, Lumber, Pulp & Paper	$0	-$9,989	-$11,930	-$21,919
Banking, Financial, Accounting Services	$0	-$120,225	-$194,687	-$314,912
Child Day Care	$0	$0	-$17,286	-$17,286
Commercial Fishing	$0	-$1,300	-$210	-$1,510
Construction	$0	-$72,675	-$774,638	-$847,312
Education: Schools, Colleges, Universities	$0	-$240	-$417,024	-$417,264
Govt: Federal, incl Military	$0	-$14,112	-$115,292	-$129,404
Govt: State & local, non-educ	$0	-$869	-$265,647	-$266,516
Hospitals, Doctors, Dentists	$0	-$4	-$251,486	-$251,491
Hotels and Lodging Places	-$1,188,057	-$14,899	-$37,575	-$1,240,532
Household Cleaning Services	$0	$0	-$7,910	-$7,910
Insurance	$0	-$1,723	-$34,846	-$36,569
Landscaping, Horticulture, Greenhouses	$0	-$7,112	-$13,417	-$20,530
Legal Services	$0	-$12,098	-$39,296	-$51,395
Manf: Boat Building & Repair	$0	-$1	-$40	-$40
Manf: Clothing, Shoes, Leather Goods Manf	$0	-$656	-$15,661	-$16,316
Manf: Concrete, Cement, Brick	$0	-$3	-$36	-$38
Manf: Food processing	$0	-$3,065	-$4,836	-$7,901
Manf: Furniture & Wood Products	$0	-$680	-$7,879	-$8,559
Manf: Newspapers	$0	-$12,146	-$4,874	-$17,020
Manf: Other	$0	-$10,551	-$62,987	-$73,538
Manf: Petroleum, Chemicals, & Mining	$0	-$12,884	-$105,506	-$118,389
Manf: Printing and publishing	$0	-$9,563	-$5,990	-$15,553
Non-profit organizations	$0	-$1,637	-$38,787	-$40,423
Other Business Services	$0	-$149,116	-$149,729	-$298,845
Real estate	$0	-$152,751	-$455,753	-$608,504
Recreation: Bowling Alleys & Pool Halls	$0	-$2	-$903	-$905
Recreation: Golf and Amateur Team Sports	$0	-$740	-$8,326	-$9,066
Recreation: Movie Theaters	$0	-$15,005	-$22,235	-$37,240
Recreation: Other Amusement Facilities	$0	-$4,740	-$32,759	-$37,500
Retail: Auto Parking & Car Wash	$0	-$835	-$5,826	-$6,661
Retail: Auto Rental	$0	-$6,251	-$13,338	-$19,589
Retail: Auto Repair & Service	$0	-$8,857	-$36,932	-$45,789
Retail: Automobile Sales & Service	-$1,467,858	-$4,577	-$108,349	-$1,580,784
Retail: Beauty and Barber Shops	$0	$0	-$9,875	-$9,875
Retail: Clothing & Shoes	$0	-$446	-$28,148	-$28,594
Retail: Department Stores	-$927,524	-$621	-$60,273	-$988,417
Retail: Equipment Rental	$0	-$3,779	-$8,031	-$11,809
Retail: Furniture	$0	-$704	-$37,387	-$38,091
Retail: Grocery Stores	-$766,466	-$684	-$69,996	-$837,146
Retail: Home Improvement Stores	$0	-$1,211	-$32,010	-$33,221
Retail: Laundry Services	$0	-$8,207	-$11,884	-$20,091
Retail: Miscellaneous	$0	-$8,866	-$142,566	-$151,432
Retail: Photographic Studios	$0	-$5,456	-$6,325	-$11,781
Retail: Restaurants	-$1,350,039	-$16,593	-$152,310	-$1,518,942
Retail: Travel Agencies	$0	-$6,218	-$1,267	-$7,485
Retirement Homes & Elder-Care	$0	$0	-$14,742	-$14,742
Transport: Air Transportation	$0	-$3,550	-$11,538	-$15,088
Transport: Bus Services	$0	-$553	-$4,284	-$4,838
Transport: Seaport & Water Transp.	$0	-$1,301	-$9,361	-$10,662
Transport: Trucking	$0	-$30,840	-$58,914	-$89,753
TV, Radio, Other Comm Services	$0	-$81,405	-$88,803	-$170,208
Utilities: Electricity & Nat. Gas	$0	-$41,297	-$77,781	-$119,078
Utilities: Water, Sewer, Trash Services	$0	-$24,623	-$49,447	-$74,070
Wholesale, Warehousing & Distribution	$0	-$67,569	-$221,667	-$289,236
Total	-$5,699,944	-$959,599	-$4,360,585	-$11,020,127

Table 7. Complete Discontinuation of Vehicle Access Scenario--Employment Impacts

Industry	Direct Employment Impacts (Jobs)	Indirect Employment Impacts (Jobs)	Induced Employment Impacts (Jobs)	Total Employment Impacts (Jobs)
Advertising	0.0	-0.1	0.0	-0.1
Agri, Forestry, Lumber, Pulp & Paper	0.0	0.0	-0.1	-0.1
Banking, Financial, Accounting Services	0.0	-1.2	-1.5	-2.7
Child Day Care	0.0	0.0	-0.4	-0.4
Commercial Fishing	0.0	-0.1	0.0	-0.1
Construction	0.0	-1.0	-6.1	-7.1
Education: Schools, Colleges, Universities	0.0	0.0	-10.6	-10.6
Govt: Federal, incl Military	0.0	-0.2	-1.9	-2.0
Govt: State & local, non-educ	0.0	0.0	-4.4	-4.4
Hospitals, Doctors, Dentists	0.0	0.0	-3.4	-3.4
Hotels and Lodging Places	-23.2	-0.3	-0.7	-24.3
Household Cleaning Services	0.0	0.0	-0.8	-0.8
Insurance	0.0	0.0	-0.3	-0.3
Landscaping, Horticulture, Greenhouses	0.0	-0.2	-0.3	-0.5
Legal Services	0.0	-0.2	-0.5	-0.7
Manf: Boat Building & Repair	0.0	0.0	0.0	0.0
Manf: Clothing, Shoes, Leather Goods Manf	0.0	0.0	-0.2	-0.2
Manf: Concrete, Cement, Brick	0.0	0.0	0.0	0.0
Manf: Food processing	0.0	0.0	0.0	0.0
Manf: Furniture & Wood Products	0.0	0.0	-0.1	-0.1
Manf: Newspapers	0.0	-0.1	-0.1	-0.2
Manf: Other	0.0	-0.1	-0.3	-0.4
Manf: Petroleum, Chemicals, & Mining	0.0	0.0	-0.3	-0.3
Manf: Printing and publishing	0.0	-0.1	0.0	-0.1
Non-profit organizations	0.0	0.0	-1.1	-1.1
Other Business Services	0.0	-3.0	-2.5	-5.5
Real estate	0.0	-1.0	-1.2	-2.2
Recreation: Bowling Alleys & Pool Halls	0.0	0.0	0.0	0.0
Recreation: Golf and Amateur Team Sports	0.0	0.0	-0.2	-0.3
Recreation: Movie Theaters	0.0	-0.2	-0.3	-0.4
Recreation: Other Amusement Facilities	0.0	0.0	-1.2	-1.2
Retail: Auto Parking & Car Wash	0.0	0.0	-0.2	-0.3
Retail: Auto Rental	0.0	-0.1	-0.1	-0.2
Retail: Auto Repair & Service	0.0	-0.1	-0.4	-0.5
Retail: Automobile Sales & Service	-17.0	-0.1	-1.3	-18.3
Retail: Beauty and Barber Shops	0.0	0.0	-0.4	-0.4
Retail: Clothing & Shoes	0.0	0.0	-0.8	-0.8
Retail: Department Stores	-22.2	0.0	-1.4	-23.6
Retail: Equipment Rental	0.0	0.0	-0.1	-0.1
Retail: Furniture	0.0	0.0	-0.5	-0.5
Retail: Grocery Stores	-22.6	0.0	-2.1	-24.7
Retail: Home Improvement Stores	0.0	0.0	-0.6	-0.6
Retail: Laundry Services	0.0	-0.3	-0.5	-0.8
Retail: Miscellaneous	0.0	-0.2	-3.6	-3.8
Retail: Photographic Studios	0.0	-0.1	-0.1	-0.1
Retail: Restaurants	-36.1	-0.4	-4.1	-40.6
Retail: Travel Agencies	0.0	-0.2	0.0	-0.2
Retirement Homes & Elder-Care	0.0	0.0	-0.5	-0.5
Transport: Air Transportation	0.0	0.0	-0.1	-0.2
Transport: Bus Services	0.0	0.0	-0.1	-0.1
Transport: Seaport & Water Transp.	0.0	0.0	0.0	-0.1
Transport: Trucking	0.0	-0.3	-0.5	-0.8
TV, Radio, Other Comm Services	0.0	-0.5	-0.4	-0.9
Utilities: Electricity & Nat. Gas	0.0	-0.1	-0.2	-0.3
Utilities: Water, Sewer, Trash Services	0.0	-0.1	-0.2	-0.4
Wholesale, Warehousing & Distribution	0.0	-0.6	-2.1	-2.7
Total	-121.2	-11.0	-58.7	-190.9

Table 8. Complete Discontinuation of Vehicle Access Scenario--Tax Revenue Impacts

Tax Type	Tax Revenue Impacts (2004 Dollars)
Federal Personal Income Taxes	-$393,405
Federal Corporate Profits Taxes	-$141,298
Federal Payroll Taxes	-$526,719
State Personal Income Taxes	-$123,336
State Corporate Profits Taxes	-$26,396
State Payroll Taxes	-$5,996
Local Business Property Taxes	-$251,025
State & Local Sales Taxes	-$446,322
Total	-$1,914,497

Table 9. Daytime-Only Vehicle Access Scenario--Impacts on Regional Sales (Output)

Industry	Direct Sales Impacts (2004 Dollars)	Indirect Sales Impacts (2004 Dollars)	Induced Sales Impacts (2004 Dollars)	Total Sales Impacts (2004 Dollars)
Advertising	$0	-$1,128	-$351	-$1,479
Agri, Forestry, Lumber, Pulp & Paper	$0	-$1,769	-$2,113	-$3,881
Banking, Financial, Accounting Services	$0	-$21,289	-$34,474	-$55,763
Child Day Care	$0	$0	-$3,061	-$3,061
Commercial Fishing	$0	-$230	-$37	-$267
Construction	$0	-$12,869	-$137,168	-$150,037
Education: Schools, Colleges, Universities	$0	-$43	-$73,844	-$73,886
Govt: Federal, incl Military	$0	-$2,499	-$20,415	-$22,914
Govt: State & local, non-educ	$0	-$154	-$47,039	-$47,193
Hospitals, Doctors, Dentists	$0	-$1	-$44,532	-$44,532
Hotels and Lodging Places	-$210,386	-$2,638	-$6,654	-$219,678
Household Cleaning Services	$0	$0	-$1,401	-$1,401
Insurance	$0	-$305	-$6,170	-$6,475
Landscaping, Horticulture, Greenhouses	$0	-$1,259	-$2,376	-$3,635
Legal Services	$0	-$2,142	-$6,958	-$9,101
Manf: Boat Building & Repair	$0	$0	-$7	-$7
Manf: Clothing, Shoes, Leather Goods Manf	$0	-$116	-$2,773	-$2,889
Manf: Concrete, Cement, Brick	$0	$0	-$6	-$7
Manf: Food processing	$0	-$543	-$856	-$1,399
Manf: Furniture & Wood Products	$0	-$120	-$1,395	-$1,516
Manf: Newspapers	$0	-$2,151	-$863	-$3,014
Manf: Other	$0	-$1,868	-$11,153	-$13,022
Manf: Petroleum, Chemicals, & Mining	$0	-$2,281	-$18,682	-$20,964
Manf: Printing and publishing	$0	-$1,693	-$1,061	-$2,754
Non-profit organizations	$0	-$290	-$6,868	-$7,158
Other Business Services	$0	-$26,405	-$26,513	-$52,918
Real estate	$0	-$27,048	-$80,702	-$107,750
Recreation: Bowling Alleys & Pool Halls	$0	$0	-$160	-$160
Recreation: Golf and Amateur Team Sports	$0	-$131	-$1,474	-$1,605
Recreation: Movie Theaters	$0	-$2,657	-$3,937	-$6,594
Recreation: Other Amusement Facilities	$0	-$839	-$5,801	-$6,640
Retail: Auto Parking & Car Wash	$0	-$148	-$1,032	-$1,180
Retail: Auto Rental	$0	-$1,107	-$2,362	-$3,469
Retail: Auto Repair & Service	$0	-$1,568	-$6,540	-$8,108
Retail: Automobile Sales & Service	-$259,883	-$810	-$19,186	-$279,879
Retail: Beauty and Barber Shops	$0	$0	-$1,749	-$1,749
Retail: Clothing & Shoes	$0	-$79	-$4,984	-$5,063
Retail: Department Stores	-$164,248	-$110	-$10,673	-$175,031
Retail: Equipment Rental	$0	-$669	-$1,422	-$2,091
Retail: Furniture	$0	-$125	-$6,620	-$6,745
Retail: Grocery Stores	-$135,728	-$121	-$12,394	-$148,244
Retail: Home Improvement Stores	$0	-$214	-$5,668	-$5,883
Retail: Laundry Services	$0	-$1,453	-$2,104	-$3,558
Retail: Miscellaneous	$0	-$1,570	-$25,245	-$26,815
Retail: Photographic Studios	$0	-$966	-$1,120	-$2,086
Retail: Restaurants	-$239,069	-$2,938	-$26,970	-$268,978
Retail: Travel Agencies	$0	-$1,101	-$224	-$1,325
Retirement Homes & Elder-Care	$0	$0	-$2,610	-$2,610
Transport: Air Transportation	$0	-$629	-$2,043	-$2,672
Transport: Bus Services	$0	-$98	-$759	-$857
Transport: Seaport & Water Transp.	$0	-$230	-$1,658	-$1,888
Transport: Trucking	$0	-$5,461	-$10,432	-$15,893
TV, Radio, Other Comm Services	$0	-$14,415	-$15,725	-$30,139
Utilities: Electricity & Nat. Gas	$0	-$7,313	-$13,773	-$21,086
Utilities: Water, Sewer, Trash Services	$0	-$4,360	-$8,756	-$13,116
Wholesale, Warehousing & Distribution	$0	-$11,965	-$39,251	-$51,217
Total	-$1,009,314	-$169,922	-$772,145	-$1,951,381

Table 10. Daytime-Only Vehicle Access Scenario--Employment Impacts

Industry	Direct Employment Impacts (Jobs)	Indirect Employment Impacts (Jobs)	Induced Employment Impacts (Jobs)	Total Employment Impacts (Jobs)
Advertising	0.0	0.0	0.0	0.0
Agri, Forestry, Lumber, Pulp & Paper	0.0	0.0	0.0	0.0
Banking, Financial, Accounting Services	0.0	-0.2	-0.3	-0.5
Child Day Care	0.0	0.0	-0.1	-0.1
Commercial Fishing	0.0	0.0	0.0	0.0
Construction	0.0	-0.2	-1.1	-1.3
Education: Schools, Colleges, Universities	0.0	0.0	-1.9	-1.9
Govt: Federal, incl Military	0.0	0.0	-0.3	-0.4
Govt: State & local, non-educ	0.0	0.0	-0.8	-0.8
Hospitals, Doctors, Dentists	0.0	0.0	-0.6	-0.6
Hotels and Lodging Places	-4.1	-0.1	-0.1	-4.3
Household Cleaning Services	0.0	0.0	-0.1	-0.1
Insurance	0.0	0.0	-0.1	-0.1
Landscaping, Horticulture, Greenhouses	0.0	0.0	-0.1	-0.1
Legal Services	0.0	0.0	-0.1	-0.1
Manf: Boat Building & Repair	0.0	0.0	0.0	0.0
Manf: Clothing, Shoes, Leather Goods Manf	0.0	0.0	0.0	0.0
Manf: Concrete, Cement, Brick	0.0	0.0	0.0	0.0
Manf: Food processing	0.0	0.0	0.0	0.0
Manf: Furniture & Wood Products	0.0	0.0	0.0	0.0
Manf: Newspapers	0.0	0.0	0.0	0.0
Manf: Other	0.0	0.0	-0.1	-0.1
Manf: Petroleum, Chemicals, & Mining	0.0	0.0	-0.1	-0.1
Manf: Printing and publishing	0.0	0.0	0.0	0.0
Non-profit organizations	0.0	0.0	-0.2	-0.2
Other Business Services	0.0	-0.5	-0.4	-1.0
Real estate	0.0	-0.2	-0.2	-0.4
Recreation: Bowling Alleys & Pool Halls	0.0	0.0	0.0	0.0
Recreation: Golf and Amateur Team Sports	0.0	0.0	0.0	0.0
Recreation: Movie Theaters	0.0	0.0	0.0	-0.1
Recreation: Other Amusement Facilities	0.0	0.0	-0.2	-0.2
Retail: Auto Parking & Car Wash	0.0	0.0	0.0	0.0
Retail: Auto Rental	0.0	0.0	0.0	0.0
Retail: Auto Repair & Service	0.0	0.0	-0.1	-0.1
Retail: Automobile Sales & Service	-3.0	0.0	-0.2	-3.2
Retail: Beauty and Barber Shops	0.0	0.0	-0.1	-0.1
Retail: Clothing & Shoes	0.0	0.0	-0.1	-0.1
Retail: Department Stores	-3.9	0.0	-0.3	-4.2
Retail: Equipment Rental	0.0	0.0	0.0	0.0
Retail: Furniture	0.0	0.0	-0.1	-0.1
Retail: Grocery Stores	-4.0	0.0	-0.4	-4.4
Retail: Home Improvement Stores	0.0	0.0	-0.1	-0.1
Retail: Laundry Services	0.0	-0.1	-0.1	-0.1
Retail: Miscellaneous	0.0	0.0	-0.6	-0.7
Retail: Photographic Studios	0.0	0.0	0.0	0.0
Retail: Restaurants	-6.4	-0.1	-0.7	-7.2
Retail: Travel Agencies	0.0	0.0	0.0	0.0
Retirement Homes & Elder-Care	0.0	0.0	-0.1	-0.1
Transport: Air Transportation	0.0	0.0	0.0	0.0
Transport: Bus Services	0.0	0.0	0.0	0.0
Transport: Seaport & Water Transp.	0.0	0.0	0.0	0.0
Transport: Trucking	0.0	0.0	-0.1	-0.1
TV, Radio, Other Comm Services	0.0	-0.1	-0.1	-0.2
Utilities: Electricity & Nat. Gas	0.0	0.0	0.0	0.0
Utilities: Water, Sewer, Trash Services	0.0	0.0	0.0	-0.1
Wholesale, Warehousing & Distribution	0.0	-0.1	-0.4	-0.5
Total	-21.5	-1.9	-10.4	-33.8

Table 11. Daytime-Only Vehicle Access Scenario--Tax Revenue Impacts

Tax Type	Tax Revenue Impacts (2004 Dollars)
Federal Personal Income Taxes	-$69,662
Federal Corporate Profits Taxes	-$25,020
Federal Payroll Taxes	-$93,268
State Personal Income Taxes	-$21,839
State Corporate Profits Taxes	-$4,674
State Payroll Taxes	-$1,062
Local Business Property Taxes	-$44,449
State & Local Sales Taxes	-$79,032
Total	-$339,007