

REPORT
OF
WILDLIFE MANAGEMENT STUDY

FINAL REPORT

Refuges and Wildlife Resources

Project: Pea Island NWR

Code: Pea Island No. 5

Date: May 5, 1978

Title: Public and Wildlife Use on Beaches of Pea Island National
Wildlife Refuge

ABSTRACT

Weekly shore-bird, ghost crab cavities, and public use counts were made on one mile sections of Pea Island National Wildlife Refuge beach and Cape Hatteras National Seashore beach during the period of June 4 through October 16, 1977. Daily public use and wildlife surveys were run on the entire Pea Island Refuge beach during the same period. Bird numbers, ghost crab cavities, public use and off-road vehicle use were recorded on Pea Island on weekends and weekdays. All activities were recorded on the daily surveys on Pea Island. No nesting activities were found on Cape Hatteras National Seashore beach but least terns made two unsuccessful attempts to nest on Pea Island Refuge. During the period of June 4 through September 4, on the two areas studied, total number of people were found to be about the same. However, bird use in total numbers, was more than 2 to 1 higher and ghost crab cavities were more than 4 to 1 higher on the Cape Hatteras Seashore beach than on Pea Island Refuge. Species richness for birds was also higher on Cape Hatteras Seashore. All factors considered the same, except that off-road vehicles were not allowed on the Cape Hatteras National Seashore beach, it appears that off-road vehicles, on the Pea Island National Wildlife Refuge beach does have a significant effect on bird use, total number, and species richness and ghost crab populations.

OBJECTIVES

The objectives of this study were stated in the original study outline as follows:

- (1) To determine the composition, type and amount of wildlife and public use on the 13.2 miles of ocean beach on Pea Island National Wildlife Refuge.
- (2) To determine any conflicts between wildlife and public off-road vehicular use.
- (3) To determine any conflicts between wildlife and non-vehicular use.

INTRODUCTION

Many factors have contributed to increased annual public use on the Pea Island National Wildlife Refuge. Pea Island Refuge had remained relatively isolated since its establishment in 1938 until the construction of the Herbert C. Bonner Bridge across Oregon Inlet in 1963-64. Public use then increased on Pea Island from a few thousand visitors to well over one million annually. In addition to better access to the refuge, other factors contributed greatly to the high public use such as increased population and tourism, increased leisure time, increased popularity of four-wheel drive vehicles and increased regulation against vehicular use on neighboring beaches. Vehicular use on Pea Island takes the form of sightseeing, beach combing, hiking, birding, swimming, sunbathing, surfing and sport fishing.

There is evidence that annual wildlife use on the Pea Island Refuge beach decreased in recent years while annual public use has intensified. Past evidence indicates direct losses of nesting colonies of terns. Disturbance is caused by vehicular travel directly through nesting colonies, or by continuous travel immediately adjacent to a colony causing undue stress on incubating adults, non-flying young and unhatched eggs. Refuge records show past beach nesting colonies of least terns and black skimmers at considerable higher levels than current nesting populations. This is also true of beach-using sandpipers, sanderling, knots, dunlins, and turnstones whose numbers have dropped greatly in recent years on the refuge beach. Past surveys show at least 46 species of birds utilizing Pea Island National Refuge beaches. The endangered peregrine falcon is a regular fall visitor to the area and the brown pelican, also endangered utilizes shore waters on the refuge. The loggerhead sea turtle, comes ashore regularly during the summer months to lay eggs on the beach and returns to sea. Intense public use can hinder turtle nesting activity, as eggs and nests can be destroyed by high ORV usage shortly after laying if the eggs are not found and transferred to a protected enclosure. Pea Island had three loggerhead turtle nests and one false crawl on the refuge during the summer of 1977. Two of the nests were transferred to a protected enclosure and allowed to hatch while the third was left on the beach to hatch naturally.

A study conducted at Back Bay National Wildlife Refuge in 1973 revealed 33 percent more observations of 23 species of birds on a

nearby non-vehicular use beach compared to the extensively traveled Back Bay National Wildlife Refuge beach. Terns and black skimmers appeared to be the species most disturbed by heavy human activity. Ghost crab activity was 99 percent higher on the non-disturbed beach than on Back Bay and the intertidal sampling of sand fleas showed 31 percent more than Back Bay with a 45 percent greater biomass.

It was for these reasons that it was felt some curtailment of indiscriminate vehicular use on the Pea Island National Wildlife Refuge beach was necessary. On April 16, 1976 a meeting between Cape Hatteras National Seashore and Park Service Regional Office personnel and Pea Island National Wildlife Refuge and Fish and Wildlife Service Regional personnel took place in Atlanta, Georgia. At the meeting, Refuge and Wildlife Resources Assistant Regional Director Lankford recommended a joint Seashore-Refuge study be initiated to determine and document public-use and wildlife-use conflicts. Due to other commitments by the Park Service, the study did not get underway that summer. In March 1977, Mr. Lankford requested that Pea Island National Wildlife Refuge personnel go ahead and conduct the study. A Wildlife Management Study outline was prepared in April 1977, submitted and approved by the Regional Director on May 3. The study was begun on May 15, and concluded on November 27, with progress reports submitted July 15 and August 24. Initially, it was to run from May 30, 1977 to September 4, 1977, but was modified in August to include the fall wildlife migrations and to be concluded towards the end of November, 1977. This final report covers the entire period.

METHODS

A. General Beach Use

This portion of the study was begun on May 15, 1977 and was run daily on the entire 13.2 miles of Refuge beach. A normal run was done by four-wheel drive vehicle and took approximately 1 1/2 hours. Visual counts of public use types, total birds and species richness were made with the aid of binoculars and tape recorder usually by one person. Daily trips ran from May 15 to September 5 when the main tourist season ended. Thereafter, only one weekday survey a week was made in addition to the usual weekend surveys. These continued until November 27.

The 13.2 miles of National Refuge Beach were divided into four unequal sections (Figure #1) as follows:

- Section 1 North Point to Oregon Inlet Coast Guard Station - 1.5 miles
- 2 Coast Guard Station to Boiler Shipwreck - 3.8 miles
- 3 Boiler to Access Ramp #6 - 2.7 miles
- 4 Access Ramp #6 to Access Ramp #8 - 5.2 miles

The data from each section was recorded separately on forms (Appendix #1) and included:

- (1) Public use - survey times, weather, tides and numbers of off-road vehicles, fishermen, swimmers, surfers, shellers, birders, sunbathers and hikers.
- (2) Wildlife use - bird species and numbers per species.

Also, since both public and wildlife uses varied considerably between weekends and weekdays, the data was separated and analyzed that way.

The Pea Island Professional staff conducted the surveys.

Another part of this phase of the study included documentation of ORV use on the three National Wildlife Refuge beach access ramps, (Figure #1). This was conducted by National Park Service personnel stationed at Cape Hatteras National Seashore. Data collected included:

- (1) Numbers of ORV utilizing each ramp
- (2) Numbers of people per ORV at each ramp
- (3) ORV - state license registration occurring at each ramp

B. Marked Mile Study

A measured one mile stretch of ocean beach was walked on both Pea Island Refuge and Bodie Island on Cape Hatteras National Seashore once a week from June 4, 1977 through September 4, 1977 (Figure #1). Comparisons in wildlife use were of primary interest as the mile on Pea Island was subjected to heavy ORV usage while the Bodie Island mile, a few miles north, was closed to summer vehicular traffic, except for regular Park Service Patrols; less than one a day. Otherwise, conditions on both beaches are very similar with the potential of supporting wildlife species of the same variety and numbers. Data collection procedures during the walked mile survey were as follows:

- (1) Each marked mile was walked once a week on consecutive days at the same time of the day. High Public use and high ORV use days were chosen which were usually on weekends with each marked mile being walked first on alternating weekends.
- (2) Each marked mile was walked on the surf side going one way and on the dune side in returning. Appropriate data were recorded in each direction on a prepared form (Appendix #2).
- (3) Data collected each trip included times, weather, tide stages number of ORV's (on Pea Island), people and their activities, bird species, numbers per species, and ghost crab activities.

ORV's, people and bird uses were recorded on one-mile walks in one direction on the surf. Ghost crab burrows were recorded on the return one-mile walk nearer to the dune line. On the non-ORV Bodie Island beach, ghost crab activities were usually so extensive that the following sampling and expansion procedures were utilized. Each marked mile was assumed 50 feet wide giving a total of 264,000 square feet. A transect was walked through this corridor, with regular stops to count all burrows in a circle with a 10 foot radius (300 square feet) with the observer at the center. A minimum of 25 samples were taken each time. From this sub-sample the total burrow count was estimated. Usually the count on Pea Island was low enough to make an actual count of every burrow on the marked mile.

All the data collections on the mile-marked surveys on both beaches were conducted by Pea Island National Wildlife Refuge personnel Larry Hartis and Tom Smith. East Coast Biologist Otto Florschultz assisted on one survey on each beach during the study. Statistical analysis of the data collected during this study was done by Assistant Manager Tom Smith, currently on LWOP status conducting graduate work at Pea Island National Wildlife Refuge through the University of Virginia.

RESULTS

Statistical Analysis of Data

The large amount of variance normally present in shorebird populations through the annual cycle (high species richness and numbers of individuals during spring and fall migrations with low values at

other times of the year) precluded the utilization of statistical tests relying on the comparison of means (time averages) and standard deviations. The data was collected in such a way that observations taken in the same survey on different sections of the beach or on the marked miles could be paired. Statistical tests were then run on the observed differences between pairs of data points. The actual test employed was the Students-t test for paired observations after Steele and Torrie (1960) and Sokal and Rolf (1969). This test removes the problems of natural time variance in the data, yet keeps the power of statistical inference.

Table 7 gives the results for comparisons of the Bodie Island and Pea Island marked mile surveys, no ORV's and ORV's respectively. Table 8 summarizes results of tests run on public use and ORV's between the four sections of beach on Pea Island for weekdays and weekends, and within a given section of beach for weekends versus weekdays. Table 9 gives the same information as Table 8 for species richness and total numbers of birds seen.

For the individual unfamiliar with statistics the following brief example should aid in interpreting the Tables. In Table 8, under ORV's on weekdays the calculated value of $-t-$ is -2.699 for a comparison of section C with D. (This value is underlined in the table for ease in locating it.) This value is greater than the critical level of that the 99.50% level. This means that we are 99.50% confident that the difference in ORV use between section

C and D is real and significant, and not due to a random occurrence. The negative sign indicates that the ORV use was greater on section D than on C (a positive value would have meant that the use was greater on C).*

A. General Beach Use

General beach use on the 13.2 miles of Pea Island National Wildlife Refuge are presented in Table 1. As can be seen, weekends and holidays are separated from weekdays by May to July, July to August, August to November periods plus a May 15 to November 27 average by the four beach length separations.

Throughout the entire period Section 1 had significantly more people and ORV use than the remaining three sections (see Tables 1 and 8). This section accounted for 59.5 percent of the people and 64.4 percent of the vehicles on weekends and 65.6 percent of the people and 68.8 percent of the ORV's on the weekdays. Although weekends and holidays accounted for about one-third of the time, over 70 percent of the public use and nearly 75 percent of the total ORV use occurred during this period.

Correspondingly, total bird species observed and total birds per mile decreased as public use increased. Table 1 analysis shows

*Sokal, R. R. and F. J. Rolf, 1969. Biometry. W. H. Freeman and Company. San Francisco. 776pp.

*Steele, R. G. D., and J. H. Torrie, 1960. Principles and Procedures of Statistics. McGraw-Hill. New York. 481pp.

that on weekends only 10.9 percent of the total birds seen were observed on Section 1. While on weekdays, when public use was much less, numbers of birds observed on this same section increased to only 12.8 percent of the total. These data indicate that bird use remains low in heavy public use areas despite intermittent days of low public use. Of the total birds observed on the entire refuge beach, 62.7 percent was seen on weekdays.

Public use decreased significantly from north to south, Section 1 through 4, (see Tables 1 and 8) on both weekends and weekdays. At the same time, it is evident that both wildlife species richness and total numbers observed per mile generally increased significantly from Section 1 to 4, (see Tables 1 and 9). We feel that Section 4 had significantly higher ORV use than Section 3, and has less adequate roadside parking, hence access is easier by ORV.

The results of the Park Service's ORV access ramps surveys are presented in Table 2. Examination reveals that nearly half of the ORV traffic enters the Refuge beach from Ramp #4 on the north end. Vehicles gain access to the entire Refuge beach through the three ramps at the rate of 24.7 per hour or 74 people per hour. Some entrance also occurs from the south end of the Refuge where Refuge and Park Service beach meet. Since the survey was conducted at random hours of the day all days of the week, in a normal 12-hour day, it can be estimated that 300 vehicles and 900 people will drive on the Refuge beach each day of the Memorial Day to Labor Day period.

Table 2 also shows that nearly half the use is by North Carolina registered ORV's. Virginia vehicles are next in abundance at 36 percent while only 15 percent are from other states. It is interesting to note that the majority of the North Carolina use occurs at Ramp #6 in the center of the National Wildlife Refuge. Another point of interest in the study was that all non-four-wheel drive vehicular use is confined to Ramp #4 where it accounted for approximately 10 percent of the ramp's use and less than 3 percent of all Pea Island National Wildlife Refuge ORV use.

Public use on the Refuge beach was divided into seven categories and is presented in Table 3 for the months of June through November, 1977. It should be pointed out that the figures shown are not expanded; rather they are expanded actual observations of use occurring during the daily sampling periods of one to three hours. As can be seen in the Table, there were 27,216 people actually observed using the Pea Island National Wildlife Refuge beach in the six-month period. Of these, 52.4 percent were fishermen and 37.2 percent were sunbathers. Note that fishing was heaviest in October and sunbathers were more active in June. Swimming was third most numerous Refuge beach activity. In total use by months, June and July respectively were the heaviest user months that together accounted for 45.3 percent of the total six-month public use. November was the month with least use, only 0.4 percent of the total.

B. Marked mile study

The general results of these walked surveys are presented in Table 4,

results of statistical analysis are shown in Table 7.

Examination of the data in Table 4 shows that public use was not significantly different on the two areas during the first 15 weeks of the study (see Table 7). Species richness, total birds seen and ghost crabs all were significantly higher on non-ORV beach, (Table 7). There was greater species richness observed on the non-ORV area and over twice as many birds and four times as many ghost crab cavities seen. Species richness on the ORV beach varied between 2 and 11 whereas on the non-ORV beach it varied between 1 and 17. The highest bird count at Pea Island was 276 as opposed to 598 on Bodie Island. Ghost crab cavities varied from 0 in late July to 30,800 in early September on Pea Island where they averaged 2,577 in the 15 surveys, and 910 to 52,800 with a 10,148 average on Bodie Island. From the Table it is very obvious that on both areas the week of heaviest usage, Survey 6, which included Independence Day, had the lowest number of bird species, numbers of birds seen, and the highest public use.

Tables 4 and 7 show results for the six weekly fall surveys after ORV use was permitted on Bodie Island. Note that public and ORV uses were significantly greater on Pea Island than on Bodie Island after Labor Day (Table 7). It is interesting to note that wildlife use on Pea Island stayed relatively the same despite the fall migration of birds, that ORV use increased by 50 percent, and that on Bodie Island where ORV use was suddenly permitted, wildlife use dropped such that there was not a significant difference between the two

areas (Table 7). This indicates that a threshold exist such that once ORV use is above this threshold value, the addition of more ORV's will not limit the number of birds remaining on the beach. The addition of ORV's up to this threshold caused small reduction in bird population on the beach. The addition of ORV's past the threshold level caused drastic reduction in bird population using the beach. Ghost crab activity likewise dropped on Bodie Island from approximately four times higher to less than twice higher than on Pea Island.

The Pea Island National Wildlife Refuge investigators reported significant ghost crab hatches once on each study area. On Bodie Island it occurred prior to the August 20-21 survey while at Pea Island it occurred a week later. Both hatches led to record ghost crab activity for two to six weeks later. For the ten weeks prior to these hatches ghost crab activities were from 10 to 40 times more plentiful on the non-vehicle Bodie Island beach. However, late summer and fall data analysis show that the ghost crab does reproduce heavily on an ORV beach as well as on a non-ORV beach but that there appears to be some affect on spring and early summer populations.

There were 28 different species of birds observed during the weekly walked mile surveys on both study areas between June 4 and September 4, 1977. The 28 species belonged to 8 different families which are listed in Table 5 along with the total number of each species seen on each area. As can be seen there were 23 different species seen on the Pea Island marked mile and 26 species on the Bodie Island marked mile, with 21 species seen on both areas. The least sandpiper

and knot were seen on Pea Island only while brown pelicans, dunlins, marbled godwit, least terns and forster's terns were seen on Bodie Island only during the marked mile surveys.

In the 15 weekly marked mile surveys, a total of 1,370 (32.6 percent) birds were observed on Pea Island and 2,855 (67.4 percent) were seen at Bodie Island for a total of 4,233 birds recorded during the study. Sanderlings were the most numerous sighted on both areas comprising 15.0 percent whereas the eight species in the tern sub-family were second in importance at Bodie Island.

The sandpiper family comprised approximately 75 percent of all bird life on both areas during the summer study period. The four species of gulls were the next most important group at Pea Island comprising 15.0 percent whereas the eight species in the tern sub-family were second in importance at Bodie Island.

Weekly population differences by species are shown in Table 6.

Here it can be seen that the June surveys showed more bird use at Pea Island and that both areas experienced record lows in late June and early July when public use was at its highest. Bodie Island bird use was heaviest from July 31 to August 14 when 64.6 percent of their total use occurred in four surveys and Pea Island's use was highest from August 6 to August 21 as 63.2 percent of their total use occurred in four surveys. Recall that of all the bird use observed on the two study areas during the 15-week study period, approximately two-thirds were observed on the non-vehicular Bodie Island beach and

about one-third on the Pea Island beach which had continuous ORV use.

Two tern colony nesting attempts were documented on Pea Island Refuge during the study period. The first colony, located 3.9 miles north of the refuge office, was discovered on June 14 and posted on June 17. The colony was checked daily. On June 25 it was found that people had driven through the colony and destroyed four of the posted signs. On July 8 this colony was inventoried and the following were found: 1 common tern nest with 2 eggs, 2 least tern nests with 2 eggs each, 3 least tern nests with one egg each, and 1 least tern nest with 2 downy young. Additionally many tracks were found in the grassy area adjacent to this colony possibly indicating that many young birds had left the nests, moved to the grassy area for protection, hence, were missing in our inventory. The second colony attempt was 2.5 miles south of the refuge headquarters. On June 27 least terns were observed conducting courtship displays in the area and on June 30, nesting appeared to have begun. However, on July 2 and on subsequent dates, no terns were seen. It was determined that some unknown disturbance caused abandonment of the area.

1972 BACK BAY STUDY

A study similar to the 1977 Pea Island-Bodie Island marked mile study was conducted at Back Bay National Refuge and a non-ORV area a few miles north called Dam Neck in the summer of 1972. Some of

the results paralleled the 1977 study and are therefore included here.

Results showed that bird usage by 23 species was 33 percent higher on the non-ORV Dam Neck beach during the three-month long study. Six species used Dam Neck exclusively and three were found only at Back Bay. High public use weekend periods show an even greater margin of use between the two beaches. Terns and black skimmers were two species most disturbed by intensive human activity on the beaches as in the 1977 Pea Island-Bodie Island study.

Further results showed that Dam Neck had 99 percent higher ghost crab activity than Back Bay. Also, sand surf fauna at Dam Neck were 31 percent higher than the same beach zone at Back Bay and total biomass in this zone was 45 percent higher at Dam Neck.

SUMMARY AND CONCLUSIONS

(1) As the level of public use on the refuge beach increases, the number of birds utilizing the beach decreases.

(2) Species richness is significantly less in areas of high public use than areas of low public use.

(3) ORV's were directly responsible for the significantly smaller bird populations on Pea Island than those observed at Bodie Is.

(4) ORV's were shown to cause greater decreases in bird population and species richness than public use along.

(5) ORV's cause significant decreases in ghost crab populations.

RECOMMENDATIONS

(1) Due to the findings of this study it is obvious that the beach should be closed during periods of high wildlife use. This corresponds to the period from April 1 to October 1. This covers the Spring and Fall shorebird migrations and the summer bird, sea turtle and ghost crab nesting times.

(2) a. Section 1 should remain open year round due to the extremely high public use in this area (which is the second most favored fishing spot on the Outer Banks).

b. Sections 2 and 3 should remain closed year round to ORVs

c. Section 4 should remain closed from April 1 to October 1 and be opened the remainder of the year for ORV use. During periods of storm activity when beach erosion is greatest, closure of this section will be at the discretion of the Refuge Manager.

d. Tern nesting areas will be posted and closed to all public uses as has been the policy in the past.

e. Additional parking areas along NC 12 may be required to facilitate access by the public (this is the responsibility of the National Park Service under memorandum of agreement dated March 30, 1977).

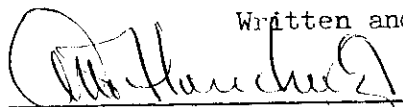
(3) It is recommended that permission be granted for publication of relevent findings in the appropriate ecological or ornithological journals.

(4) A comparable marked mile study should be performed on Pea Island and Bodie Island to judge to recovery of bird populations on Pea Island and Bodie Island to judge to recovery of bird populations on Pea Island following beach closure.

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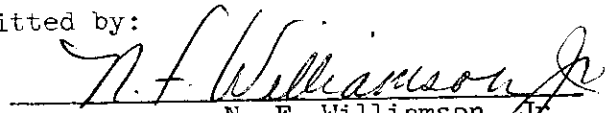
Area Office, Asheville, NC
Regional Office, Atlanta, GA
Cape Hatteras National Seashore, Manteo, NC
Pea Island National Wildlife Refuge
East Coast Biologist, Washington, NC

Written and submitted by:



Otto Florschuts, Jr.
East Coast Biologist

May 11, 1978



N. F. Williamson, Jr.
Refuge Manager, Pea Island NWR

Date: May 8, 1978

Reviewed by: _____

Date: _____

Approved by: _____

Date: _____

TABLE 1
General Beach Surveys
Pea Island NWR - 1977

May 15 - July 15

	Weekends-Holidays				Weekdays			
	People per mile	ORV's per mile	Species per Section	Total birds per mile	People per mile	ORV's per mile	Species per Section	Total birds per mile
Pt. to CGS	95	17	3	18	32	5	5	45
CGS to B	32	7	9	42	7	1	10	70
B to 6	22	2	6	53	4	*1	8	88
6 to 8	16	3	9	58	4	*1	11	82

July 16 - Aug 17

Pt. to CGS	64	12	4	31	46	6	11	101
CGS to B	28	5	8	94	16	2	10	191
B to 6	14	*1	8	169	9	*1	9	383
6 to 8	11	2	10	319	7	*1	11	427

Aug 19 - Nov 27

Pt. To CGS	104	27	6	76	44	11	8	100
CGS to B	23	6	10	78	6	1	12	131
B to 6	15	2	9	101	5	*1	10	154
6 to 8	18	3	11	106	6	1	12	151

May 15 - Nov 27 Average

Pt to CGS	88	18	4	41	40	7	7	82
CGS to B	27	6	9	71	10	1	11	130
B to 6	17	2	8	107	6	*1	9	208
6 to 8	15	3	10	161	6	*1	11	220

Symbols

Pt. - North point of Pea Island Refuge (north end)
CGS - Oregon Inlet Coast Guard Station
B - Boiler (visible remains of old shipwreck used as landmark)
6 - Beach access ramp #6
8 - Beach access ramp #8
* - Less than the number shown

Note: All numbers in table (except species) represents the average number of people, ORV's, or birds observed per mile in that section. Numbers in the species column represents the average number of species observed per section of beach.

Table 2
Park Service Random ORV Ramp Survey
Pea Island NWR - 1977

Ramp No.	Vehicles per hour	People per ORV	o/o State Registered		
			N.C.	Va.	Others
4	11.3	3.0	44	38	18
6	7.0	3.0	57	29	14
8	6.4	3.0	46	40	14
Totals & Averages	24.7	3.0	49	36	15

Table 3
Ocean Beach Public Use Categories & Sightings
Pea Island NWR - 1977

Public Use	June	July	Aug.	Sept.	Oct.	Nov.	Totals	Total o/o's	5/31-9/04 o/o's	5/31-9/04 Nos.
Fishing	2713	2944	1742	2199	3290	1369	14,257	52.4	45.2	7399
Swimming	378	522	307	209	26	0	1,442	5.3	7.4	1207
Surfing	108	151	84	86	6	11	446	1.6	2.1	343
Shelling	243	293	250	74	56	19	935	3.4	4.8	786
Birding	10	3	13	0	0	0	26	0.1	0.2	26
Sunbathing	2398	2052	1632	2051	1126	327	10,036	37.1	40.2	6582
Hiking	3	20	1	0	0	0	24	0.1	0.1	24
Totals	6353	5985	4029	4619	4504	1726	27,216	100.0	100.0	16,367
o/o's	23.3	22.0	14.8	17.0	16.5	6.4	100.0	-	-	-
5/31-9/4 tots	38.8	36.6	24.6	-	-	-	100.0	-	-	-

TABLE 4
Marked Mile Beach Uses
Pea Island NWR - Bodie Island
1977

Sur. No.	Survey Dates	Pea Island					Bodie Island				
		Diff. Species	Total Birds	No. Crabs	No. People	No. ORV	Diff. Species	Total Birds	No. Crabs	No. People	No. ORV
1	June 4	10	57	75	9	4	13	209	2,900	35	0
2	June 11	11	60	100	10	4	10	49	3,000	9	0
3	June 18	8	26	100	58	23	12	104	1,500	24	0
4	June 24	4	25	100	17	6	8	55	2,500	13	0
5	June 29-30	7	14	300	26	7	5	13	3,520	34	0
6	July 3-4	2	6	300	119	29	1	1	3,520	126	0
7	July 9-10	4	36	300	21	5	6	68	*	12	0
8	July 23-24	7	105	0	3	2	8	137	4,312	26	0
9	July 30-31	4	79	0	39	10	13	244	2,816	44	0
10	Aug. 6-7	6	154	135	17	6	17	435	4,080	13	0
11	Aug. 10-11	11	220	98	37	14	8	571	910	13	0
12	Aug. 13-14	10	220	50	25	7	13	589	1,875	39	0
13	Aug. 20-21	9	276	26	26	7	10	115	19,960	60	0
14	Aug. 27-28	7	73	6,160	48	12	12	187	38,375	22	0
15	Sept. 3-4	7	27	30,800	42	10	7	78	52,800	15	0
Totals		-	1,378	38,655	507	146	-	2,855	142,068	485	0
Averages		7	92	2,577	34	10	-		10,148	32	0
16	Sept. 10-11	6	30	12,320	27	9	11	149	31,680	32	9
17	Sept. 17-18	7	159	16,700	21	11	9	68	12,320	16	8
18	Sept. 24-25	7	47	9,680	45	16	9	153	25,520	27	15
19	Oct. 1-2	7	43	7,920	26	8	3	37	8,800	19	5
20	Oct. 8-9	5	105	5,280	53	26	10	120	11,440	22	4
21	Oct. 15-16	9	181	1,760	58	19	8	125	1,232	18	7
Totals		-	565	53,660	230	89	-	652	90,992	134	48
Averages		7	94	8,943	38	15	8	109	15,165	22	8

*No ghost crab count taken

TABLE 5
FAMILIES AND SPECIES OF BIRDS OBSERVED ON
PEA ISLAND NWR AND BODIE ISLAND NS
1977

Species and Family	Pea Isl.	Bodie Isl.	Total
Pelicans (Pelecanidae)			
1. Brown	0	2	2
Sandpipers (Scolopacidae)			
1. Least	1	0	1
2. Semipalmated	25	55	80
3. Ruddy Turnstone	82	222	304
4. Sanderling	835	1531	2366
5. Willet	63	422	485
6. Dunlin	0	10	10
7. Whimbrel	3	2	5
8. Knot	1	0	1
9. Marbled Godwit	0	1	1
Plovers (Charadriidae)			
1. Black-bellied	16	37	53
2. Semipalmated	3	12	15
Oystercatchers (Haematopodidae)			
1. Oystercatcher	9	4	13
Gulls (Laridae)			
1. Great Black-backed	17	12	29
2. Herring	22	18	40
3. Ring-billed	9	9	18
4. Laughing	159	130	289
Terns (Laridae)			
1. Least	0	13	13
2. Common	96	191	287
3. Forster's	0	5	5
4. Sandwich	1	30	31
5. Gull-billed	1	15	16
6. Royal	8	50	58
7. Black	3	16	19
8. Black Skimmer	1	7	8
Swallows (Hirundinidae)			
1. Barn	1	2	3
Crows (Corvidae)			
1. Fish	15	5	19
Crackles (Icteridae)			
1. Boat-tailed	7	55	62
Totals - 28 species and 8 families	1378	2855	4233

Weekly Bird Survey
Pea Island NWR - Bodie Island NS

23

TABLE 7
 Marked Mile
 Pea Island NWR - Bodie Island NS
 1977

Values for Student's-t (one-tailed), number of observations (n), and level of significance (p) for differences in the numbers of birds per species group, species richness, numbers of people, and ghost crab burrows between the Bodie Island and Pea Island marked miles for the periods 6/4-9/4 and 9/10 - 10/16.

<u>6/4 - 9/4</u>			
	t	n	p
Number of people	-0.280	15	NS
Species richness	2.390	15	95.00
Terns	3.520	15	99.50
Sandpipers	2.356	15	97.50
Gulls, Grackles & Crows	-0.012	15	NS
Ghost Crab burrows	2.841	14	99.00
<u>9/10 - 10/16</u>			
Number of people	-2.303	6	95.00
ORV's	-1.954	6	90.00
Species richness	1.048	6	NS
Sandpipers	0.037	6	NS
Gulls, Grackles & Crows	1.252	6	NS
Ghost Crab burrows	1.604	6	90.00

NS - insignificant

TABLE 8
Public Use
Pea Island NWR - Bodie Island NS
1977

Values of Student's-t (one tailed), number of observations (n), and level of significance (p) of observed differences in the total number of people and ORV's between sections within sections on the refuge beach for weekdays and weekends.

WEEKDAYS

Sections	People			ORV's		
	t	n	p	t	n	p
1 - 2	9.009	39	99.95	6.872	39	99.95
1 - 3	10.242	39	99.95	8.363	39	99.95
1 - 4	10.282	38	99.95	8.198	38	99.95
2 - 3	2.881	39	99.50	4.710	39	99.95
2 - 4	3.359	38	99.50	3.304	38	99.50
3 - 4	1.524	38	90.00	<u>-2.699</u>	38	99.50

WEEKENDS

	t	n	p	t	n	p
1 - 2	7.848	44	99.95	7.585	44	99.95
1 - 3	8.850	44	99.95	8.882	44	99.95
1 - 4	9.234	44	99.95	8.642	44	99.95
2 - 3	4.811	45	99.95	6.838	45	99.95
2 - 4	4.202	45	99.95	4.760	45	99.95
3 - 4	0.140	45	NS	-4.569	45	99.95

WEEKENDS vs WEEKDAYS

	t	n	p	t	n	p
1	4.918	25	99.95	5.676	25	99.95
2	7.015	25	99.95	7.668	25	99.95
3	5.887	25	99.95	5.695	25	99.95
4	6.404	25	99.95	7.975	25	99.95

NS - insignificant

TABLE 9
Wildlife Use
Pea Island NWR - Bodie Island NS
1977

Values of Student's-t (one-tailed), number of observations (n), and level of significance (p) of observed differences in the total number of birds seen and species richness on the refuge beach between sections and within sections on weekends and weekdays.

WEEKDAYS

Sections	Species richness			Total birds		
	t	n	p	t	n	p
1 - 2	-7.664	48	99.95	-4.315	48	99.95
1 - 3	-3.883	48	99.95	-4.759	48	99.95
1 - 4	-9.981	47	99.95	-4.211	47	99.95
2 - 3	4.958	48	99.95	-3.628	48	99.95
2 - 4	-1.383	47	99.00	-2.939	47	99.50
3 - 4	-6.632	47	99.95	-0.211	47	NS

WEEKENDS

1 - 2	-2.637	46	99.00	-1.527	46	95.00
1 - 3	-3.938	46	99.95	-3.951	46	99.95
1 - 4	-9.256	46	99.95	-3.389	46	99.50
2 - 3	5.294	48	99.95	-2.314	48	97.50
2 - 4	-1.350	48	90.00	-3.136	48	99.95
3 - 4	-8.230	48	99.95	-2.084	48	95.00

WEEKENDS vs WEEKDAYS

1	-2.456	21	97.50	-2.348	21	97.50
2	-3.438	21	99.50	-2.964	21	99.50
3	-1.263	21	NS	-2.657	21	99.00
4	-2.418	21	97.50	-1.530	21	90.00

NS - insignificant

LOCATION: FROM: _____ TO: _____

[illegible]

PEA ISLAND/BODIE ISLAND

Time:

Wind:

Temperature:

Western Sandpiper

Ruddy Turnstone

Dunlin

Sanderling

Black-bellied Plover

Willet

Terns: Royal

Common

Least

Gull-billed

Sandwich

Gulls: Laughing

Ring-billed

Great Black-backed

Herring

Fish Crow

Grackles

Others

Public Use

ORV'S

Fish

Swim

Sun

Surf

Shell

Other

FIGURE I

BODIE IS.
NATIONAL
PARK
SERVICE

SOUTH NAGSHEAD BEACH

(12)

BODIE ISLAND
MARKED MILE

COQUINA BEACH

NORTH POINT

RAMP #4

COAST GUARD STATION

PEA ISLAND
MARKED MILE

(12)

PEA ISLAND
NATIONAL
WILDLIFE
REFUGE

BOILER
SHIP WRECK

REFUGE
HEADQUARTERS
RAMP #6

NORTH POINT TO RAMP #8, 13.2 MI.

RAMP #8

PAMLICO
SOUND

PRESIDENTIAL PROCLAMATION No. 2284 5-9-34

OREGON

INLET

ATLANTIC

