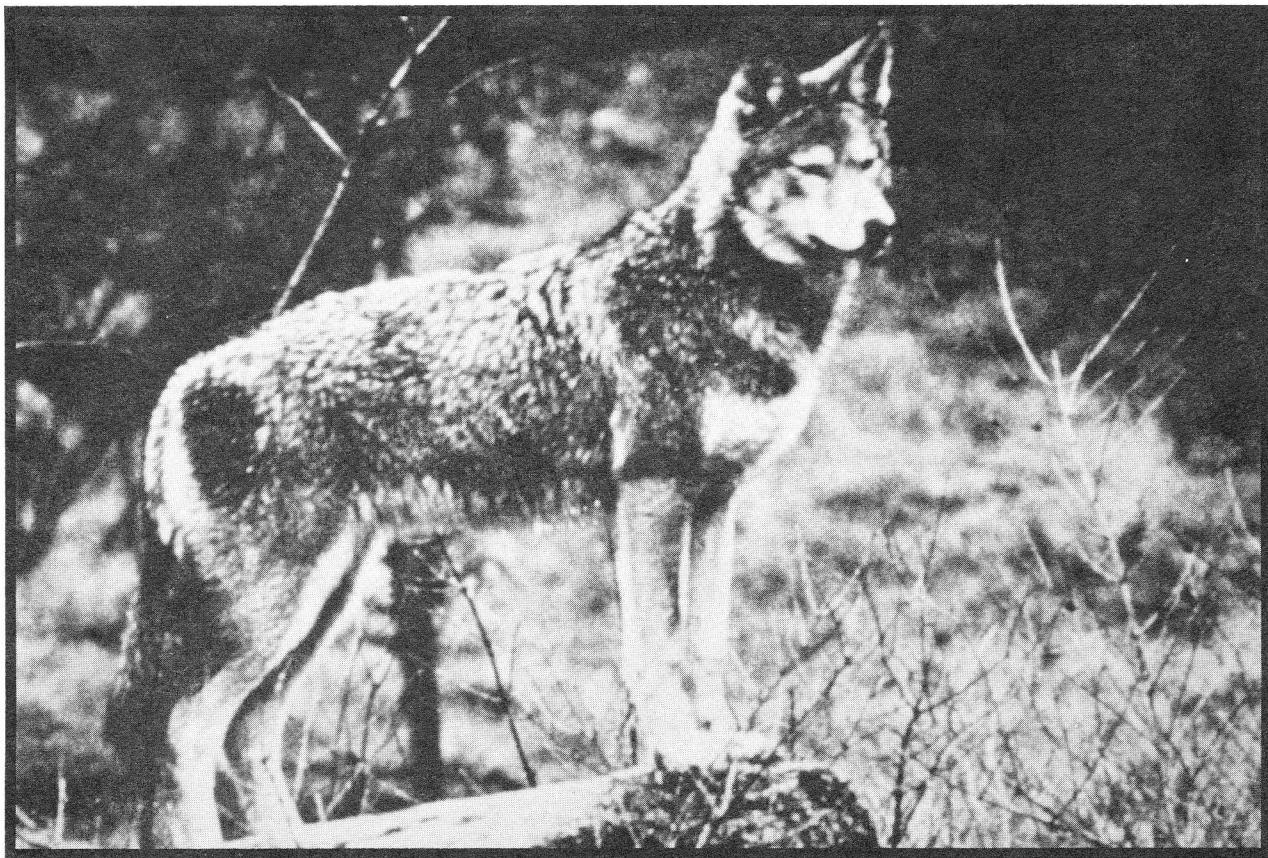


RED WOLF MANAGEMENT SERIES  
TECHNICAL REPORT NO. 6

**RED WOLF PROPAGATION  
ON  
HORN ISLAND, MISSISSIPPI**



SOUTHEAST REGION  
NATIONAL PARK SERVICE  
AND  
U.S. FISH AND WILDLIFE SERVICE

**RED WOLF PROPAGATION ON HORN ISLAND, MISSISSIPPI:  
RED WOLF ECOLOGICAL STUDIES**

**FINAL REPORT**

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PROJECT TITLE: Red Wolf Propagation on Horn Island, Mississippi

STUDY TITLE: Red Wolf Ecological Studies

### ABSTRACT

The red wolf (*Canis rufus*) propagation project in Mississippi has exceeded expectations. A pair of wolves was placed in an enclosure on Horn Island on 10 January 1989. The adults quickly acclimated to their new surroundings. They were fed dried dog food and game supplied by the Mississippi Department of Wildlife, Fisheries, and Parks. The female gave birth to three male and four female pups on 7 May. All nine wolves were released into the wild on 31 July.

Once the wolves were released, they quickly adapted to island life. The adults rapidly learned to hunt and provide for their offspring. The unexpected death of the female from pancreatic cancer altered the research plan, but had little affect on survival or growth of the pups. The removal of the adult male and two male pups in early January 1990 caused us to further modify the research goals for the year.

It is apparent from the data generated to date that the wolves use the entire island. They routinely range over large expanses of the island in a single night. The prey base on the island appears to be larger than estimated. The wolves feed predominantly on cottontails (*Sylvilagus floridanus*). Conservative estimates, based on their food consumption while in captivity, indicate that a wolf eats approximately one rabbit per night. Even though there have been five to seven wolves free on the island for six months, they have had little effect on rabbit density or distribution. Recently, we have begun to detect a shift to younger individuals in the rabbit population. There has also been a small decrease in raccoon (*Procyon lotor*) numbers and a pronounced shift in their use of habitats. Raccoons avoid areas frequented by the wolves and do not venture far from dense cover. Nutria (*Myocastor coypus*) also appears to be avoiding open areas.

Investigations on the biology of red wolves on Horn Island, Mississippi, are expected to continue.

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## INTRODUCTION

The red wolf (*Canis rufus*) is the native wolf of the Southeast (Nowak 1979). Originally, it inhabited forests and swamps from central Texas to the Atlantic and from the Gulf Coast to the Ohio Valley and Pennsylvania. The red wolf was extirpated from most of its range by the 1930's, although it survived in isolated pockets in the lower Mississippi Valley until much later (Wolfe 1972; Paradiso and Nowak 1972). The last wild wolves inhabited coastal prairies and salt marshes in east Texas and Louisiana. All of the red wolves now in captivity are descendants of 15 individuals trapped in east Texas (Parker *et al.* 1989).

The red wolf is an opportunistic predator which primarily preys on small mammals. Studies in east Texas and Louisiana indicated that the wolves feed almost exclusively on rabbits (*Sylvilagus aquaticus* and *S. floridanus*), nutria (*Myocastor coypus*) and cotton rats (*Sigmodon hispidus*) (Shaw 1975; Carley 1975). Data from the 1978 release of red wolves on Bulls Island, South Carolina, confirmed that small mammals comprise the major food items in the diet, but plant material, insects, fish, birds (American coot, *Fulica americana*) and deer (*Odocoileus virginianus*) are also consumed (Parker 1986; 1987). Raccoons (*Procyon lotor*) are also occasionally killed and eaten by red wolves (Parker, pers. comm.).

As part of the Red Wolf Recovery Plan, the U.S. Fish and Wildlife Service, under an agreement with the National Park Service (NPS), placed an adult pair of red wolves on Horn Island, Mississippi. The male came from the Audubon Zoo in New Orleans, Louisiana, and the female was from the wolf colony at the Point Defiance Zoo in Tacoma, Washington. Both animals were raised in captivity. When they were

brought to Horn Island, the male was five years of age and the female was six. The primary purpose of the project was to produce wild offspring for restoration projects elsewhere. A secondary object, and the one that this report will emphasize, was to conduct research on the biology of red wolves and the effect of wolf predation on a closed population of small mammals (Parker 1987; 1988).

The specific objectives of this study were: (1) to obtain information on management techniques and the biology of red wolves under island conditions and (2) to provide a base (index) for studies of predator-prey relationships.

## PROJECT OVERVIEW

The red wolves were flown to Mississippi from Alligator River National Wildlife Refuge (ARNWR), North Carolina, on 10 January 1989 and were released into a 15.2 x 15.2 m holding pen on Horn Island the next day. They were fed dried dog food and/or fresh meat (deer, beaver, *Castor canadensis*, and cottontails) supplied by the Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP). They quickly acclimated to their new surroundings and, while still in the pen, the female became pregnant and gave birth to seven healthy pups (3 males and 4 females) on 6 May. The mean weight of the pups was 370 g on 7 May. On 12 July, the pups were transported to Ocean Springs where transmitters were surgically implanted. Their weights ranged from 4.4 - 4.8 kg. On 28 July, the wolves were captured, given their final worming and vaccinations, and weighed. The female weighed 25 kg, the male 33.7 kg, and the pups 6.3 kg (5.7 -6.5 kg). All nine wolves were released into the wild on 31 July. The adult female was found dead on 27 September; a necropsy performed at the Wildlife Disease Laboratory in Madison,

Wisconsin, determined that she died of pancreatic cancer. The adult male and two male pups were trapped and taken to ARNWR by U. S. Fish and Wildlife personnel in January 1990. Two male and three female wolves remain free on the island.

The original plan was to keep the adult wolves in the pen for two weeks before release. It was then decided to keep the pair in the pen until the female became pregnant. Finally, the Recovery Team decided that pup survival would be enhanced if the wolves were cared for until the pups were 12 weeks old. The entire family of wolves were released when the pups were 83 days of age.

Two unanticipated developments prompted the Red Wolf Recovery Team to suggest a further modification of the Horn Island project in late November 1989. These were the deaths of several breeding-age, male wolves at ARNWR and Bulls Island, South Carolina, and the better-than-expected pup production on the Bulls Island and Horn Island propagation projects (4 and 7 pups, respectively). A series of mishaps created a critical shortage of "wild" breeding-age, male wolves. Therefore, decisions were made to move the adult male from Horn Island to ARNWR, where he was desperately needed for breeding this year, and to allow some of the Horn Island pups to remain on the island over the upcoming year. A suitable mate for one of the female pups will be brought to Horn Island in the fall, at which time the other, remaining wolves will be removed and released at a mainland site.

## METHODS

**Radio telemetry** - Red wolf movement was monitored by radio tracking.

Locations were determined by triangulation from established points on the island. We were generally successful in locating the adults, but the signals from the pup (implanted) transmitters were often too weak to pick up.

Wolf movement was monitored intermittently from the time of release. Initially, considerable effort was put into tracking the wolves, but when it became apparent that they were ranging over a large part of the island in a single night, this effort diminished. No attempt was made to monitor wolf movement throughout the night, since we were unable to keep-up with them on foot. The daytime bedding sites were also determined on an irregular basis. (Since the pups were whelped in a pen there were no den sites to monitor.)

**Population indices** - Three independent methods were employed to establish an index of the relative abundance of small mammals on Horn Island. They were: (1) catch per unit effort studies, (2) number of visits to baited tracking stations, and (3) the number of animals traversing the cross-island transects. The three techniques were run concurrently, which allowed for a better comparison of the three indices.

The three sets of assessment lines which were established on Horn Island in 1984 (Wolfe 1985) were trapped for four nights biannually (winter and summer) using tag and release and removal techniques. Within each habitat type (beach dune, relic dune, meadow, marsh, and forest), an assessment line consisting of 10 stations placed 30 meters apart was established. A Tomahawk live trap (25 cm x 25 cm x 70 cm long) and a large Sherman live trap (8 cm x 9 cm x 23.5 cm long) were placed at each station. In addition, a rat trap was placed midway between the stations for a total of nine snap traps per line. The Tomahawk traps were baited with apples; the Shermans

and snaps with a mixture of peanut butter, rolled oats, and sardines.

Assessment lines were trapped before the wolves were released in January - February and June - July of 1989 and in January - February 1990 approximately six months after their release.

Permanent tracking stations were established in all key habitats where the soil was suitable for tracking. Thirty m<sup>2</sup> plots were laid-out in suitable habitat in the general vicinity of the three assessment lines used for trapping. On each line, ten m<sup>2</sup> plots were placed in forest, relic, and beach dune areas. The plots were set approximately 60 m apart. They were raked clear of all debris, smoothed and baited, and checked daily for three days during both the winter and the summer. Trends in the total number of stations visited by all mammals on the island were compared by season.

In order to establish the number tracks left by rabbits, raccoons, or wolves crossing specific parts of the island, three cross-island trails were established. These trails were located as close as possible to the trapping lines. They were raked smooth and monitored for tracks for three consecutive days during the winter and again in the summer.

The bait stations and cross-island transects were run concurrently with the assessment lines. However, the wolves were attracted to the assessment lines by the rabbits in the traps and caused a biased reading on the west transect due to its close proximity to the west relic dune assessment line. The bait stations and cross island

transects were run again in May 1990 in order to determine the extent of that bias.

In addition, the locations of wolf tracks and other signs of activity (e.g. digging, prey capture, feeding, and scent marking) outside of the tracking station and/or cross-island trails were recorded.

**Age determination** - Cottontail rabbits were necropsied to determine their reproductive condition and general health. Eye lenses were removed, fixed in 10 percent formalin, dried, and weighed to determine age (Hill 1966). The cottontails were placed into one of two age classes (yearlings vs one year of age or older) to determine if the ratio of juveniles to adults had changed during the time that the wolves have been freely ranging on the island.

A total of 66 rabbits (24 from the present study plus 42 from Esher *et al.* 1988) had been collected for necropsy and age determination prior to the release of the wolves. During the first trapping session after release, the wolves killed 43 of the rabbits trapped on the assessment lines. We were able to salvage 35 of them for age determination. Due to the high mortality of rabbits in live traps, we decided to suspend further collection of rabbits until after the summer trapping session.

The use of rabbits killed in traps gave us a sample from all habitat types and areas not previously sampled, but many of these animals were so mangled that their reproductive condition could not be determined.

**Scat analysis** - During all phases of research on Horn Island, a concerted

effort was made to collect scats for food habit analysis. Upon collection, scats were placed in plastic bags and frozen until they could be analyzed. In the laboratory, they were thawed and washed through a series of mesh screens to separate fecal material. Hair, feathers, teeth, bones, scales, and exoskeletons were examined macro-and microscopically.

## RESULTS

**Radio telemetry** - Radio tracking began on 1 August, 1989. The entire wolf family initially stayed within 0.3 km of the pen in the area west of the ranger station. Within a week they had moved to the relict dune ridge south of Ranger Lagoon and remained in that area for about two weeks. The female and the pups did not move much during that period, while the male ranged over about a mile of the island. By 11 August, the center of activity for the family had moved to about 0.3 km east of the ranger station and all of the animals were using a section of the island from the ranger station east about two miles to the "horseshoe" area.

By mid-September, the male was ranging as much as three miles west of the ranger station while the pups retained their center of activity east of the station. On 15 September the female was located near the eastern tip of the island, 11 km east of the ranger station. The female and several of the pups were observed several times during the following week and appeared to be in good condition. The adult female looked healthy and alert and the pups appeared to be about half-grown.

On 27 September, the adult female was found dead about three miles east of the ranger station. She was active the night before and at 7 am the mortality sensor in her collar was detected. Her carcass was located at 9 am. Supplemental food was

provided for the pups for the next week. On 28 September, two of the pups were seen at close range. They appeared to be in excellent condition. Radio tracking indicated that the male was taking 1 - 4 of the pups on hunting excursions with him each night. The male was ranging over most of the island while the pups were distributed over a 3 km area east of the ranger station.

From October through December, animals were located approximately twice a week. By late October, it was evident that the pups, like the male, were ranging over the entire island. They were usually located in pairs, occasionally in groups of three. No sightings of the wolves were reported by visitors during the period, indicating that the wolves were avoiding people and showing normal, wild behavior.

**Population indices** - A comparison of the number of rabbits captured before and after the wolves were released on the island is shown in Figure 1. More rabbits were captured after the wolves were released than were captured in any of the prior trapping sessions. Approximately equal numbers of rabbits were captured in the three different areas. Fewer raccoons were captured after the wolf release (Fig. 2). There were no raccoons captured on the west assessment lines after the wolf release.

The number of bait stations visited by rabbits and raccoons is given in Figures 3, 4, and 5. The number of stations visited varied by habitat, area, species, and time relative to the wolf release. In all area-habitat combinations, except the central beach area, fewer stations were visited by raccoons in the spring and summer than in the winter. The number of raccoon visits decreased in all areas and habitats after the wolves were released. Rabbits also tended to visit the bait stations less during spring

and summer than in the winter. However, the rabbit response to wolf release was more complex. After the wolves were released, the number bait stations visited by rabbits decreased in the central and western beach dunes but remained the same in the eastern beach dunes. On the other hand, the number of forest and relic dune bait stations visited by rabbits either increased or remained the same in all three areas.

The results of the track counts on the cross-island transects are given in Table 1. As with the bait stations, there were fewer tracks present during the warmer months than in the colder months. A gradual decrease in the number of rabbit tracks occurred after the release of the wolves, but it is too early to determine if this is an actual or perceived trend. There was a sharp decrease in the number of raccoon tracks present in the cross island trails immediately after the wolves were released. Few nutria tracks were found in the transects prior to the wolf release and none afterwards.

**Age determination** - The results of age determinations on a total of 101 rabbits are given in Figures 6 and 7. Before the wolves were released, more than 80 percent of the rabbits collected were more than one year old (Fig. 6). Specimens collected approximately six months after the wolves were released showed an increase in the proportion of young (< 1 year old) rabbits. A large increase in rabbit numbers appears in the 0.6 - 1.0 year age class, with corresponding declines in the 1.1 -2.0 year groups (Fig. 7). Surprisingly, the percent of rabbits in the > 2.0 year age class remained the same.

**Scat analysis** - The results of the analysis of wolf scat collected from two periods are given in Figure 8. Analysis of scats collected during August and

September indicated that the wolves were feeding on rabbits, raccoons, and nutria. Cursory examination of scats collected in October through December 1989 indicated that the wolves were feeding primarily on rabbits. (Evidence of the wolves scavenging on dead dolphins and fish was observed on the beach). Of the scats recovered during January 1990, those analyzed contained only rabbit remains.

## DISCUSSION

Since little was known about the biology of red wolves in the wild much was learned about their movements, social behavior, reproductive success, diet, and predator-prey relationships in this study. Although it is too early to determine if the data gathered so far in the study are valid, preliminary findings suggest that: (1) the wolves use the entire island and will regularly cover more than 8 km in a single night; (2) the wolves have had little effect on rabbit density or distribution, although age structure is beginning to show change; (3) the rabbit population on Horn Island may be much larger than originally estimated; (4) there has been a small decrease in raccoon numbers and a pronounced shift in their use of habitats; (5) wolves prey predominantly on rabbits, but they do kill and eat an occasional raccoon or nutria.

Horn Island, Mississippi, appears to be an excellent place to rear and study red wolves. All of the wolves removed from the island were in superb condition. The male weighed over 38 kg after five months on the island and the pups were described by refuge staff as being 20 - 30% larger than animals of comparable age at ARNWR. We had little difficulty radio tracking the adults and wolf scats were easier to find than expected. In addition, the sand beaches enabled us to piece together some wolf behavioral sequences (e.g. exploring/hunting in groups, feeding on the beaches,

running our trap lines) as well as use tracks to estimate the relative abundance of prey species.

Changes in the project coupled with the untimely death of the female caused some shortfalls in our research. The increase in the period of time that the wolves were held in the pen enabled us to get in an additional, pre-wolf release sampling period, but it also eliminated any chance of observing the wolves at a denning site or observing behavioral changes associated with birth and care of the offspring. In addition, the death of the female and subsequent removal of the adult male and two pups coupled with the weak signals from the implanted transmitters severely restricted our ability to radio track the wolves.

It is apparent that we have just begun to understand the biology of red wolves. This species is more adaptable than we expected. It was surprising how quickly they adjusted to island life and how rapidly naive animals learned to hunt and fend for themselves. We believe that, as more data becomes available from this and other island projects, biologists will be able to make better management decisions on this and other large carnivores.

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Table 1. Mean number of Cross Island Transect crossings by species and period.

TRANSECT	DATE	N	MEAN SETS OF TRACKS			
			RABBITS	WOLVES	RACCOONS	NUTRIA
CENTRAL	JAN 89	3	183.3	-	28.0	1.7
	NOV 89	3	117.0	8.0*	0.3	0.0
	JAN 90	3	135.0	4.7*	2.7	0.0
	MAY 90	2	71.0	1.0	0.0	0.0
EAST	JAN 89	3	130.3	-	16.0	2.7
	NOV 89	3	82.0	6.0	1.0	0.0
	JAN 90	3	93.0	1.0	0.0	0.0
	MAY 90	2	60.0	7.0	0.0	0.0
WEST	FEB 89	3	166.3	-	22.7	5.7
	NOV 89	3	85.3	2.7	0.3	0.0
	FEB 90	3	130.3	**	5.0	0.0
	MAY 90	2	31.5	1.5	0.0	0.0

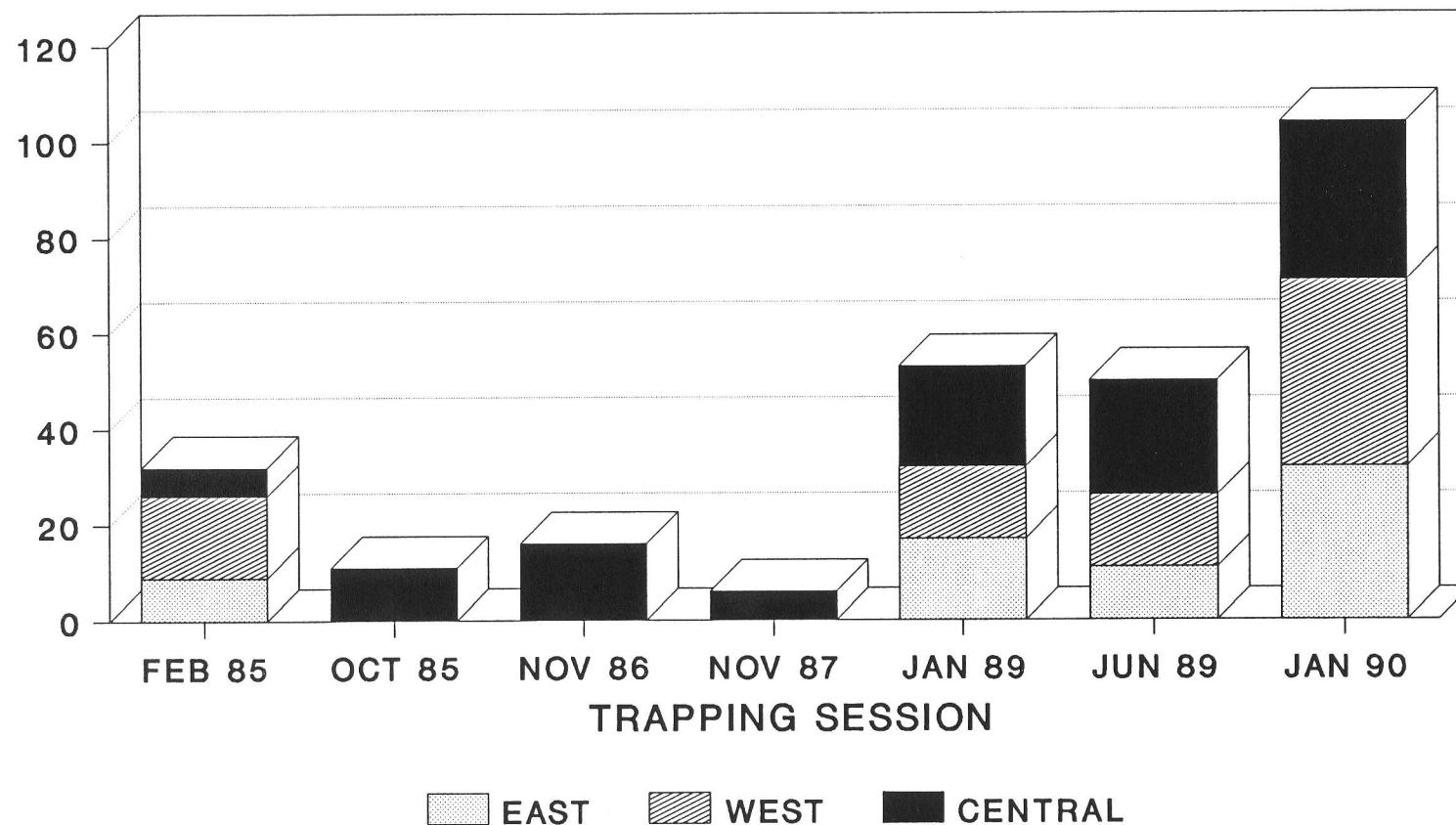
\* Wolves were hunting on tractor path.

\*\* Wolves were patrolling transect due to proximity to trap line.

Figure 1. Number of cottontail rabbits (*Sylvilagus floridanus*) captured on assessment lines.

# RABBITS CAPTURED ON ASSESSMENT LINES

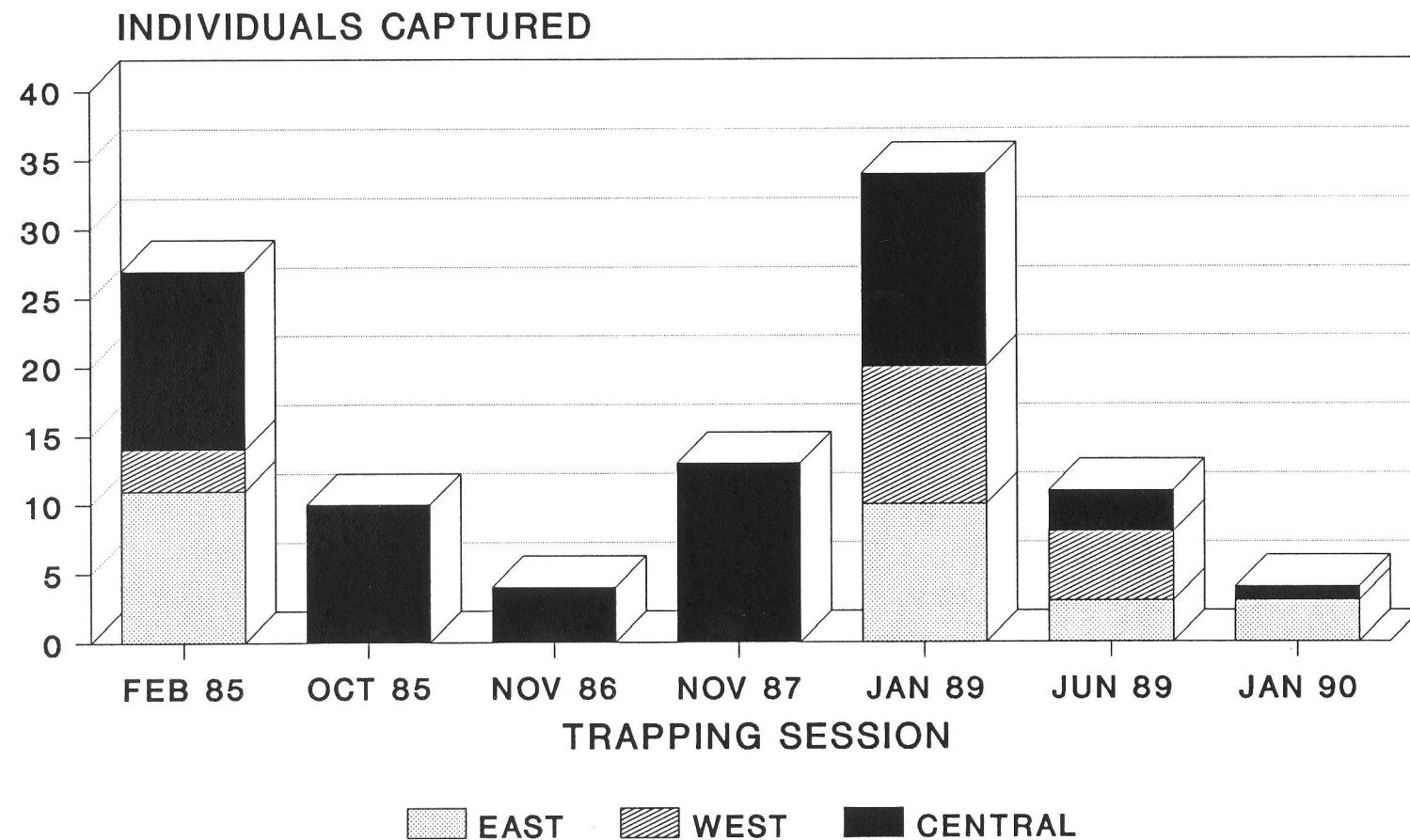
INDIVIDUALS CAPTURED



WOLVES RELEASED AFTER JUN 89

Figure 2. Number of raccoons (*Procyon lotor*) captured on assessment lines.

# RACCOONS CAPTURED ON ASSESSMENT LINES

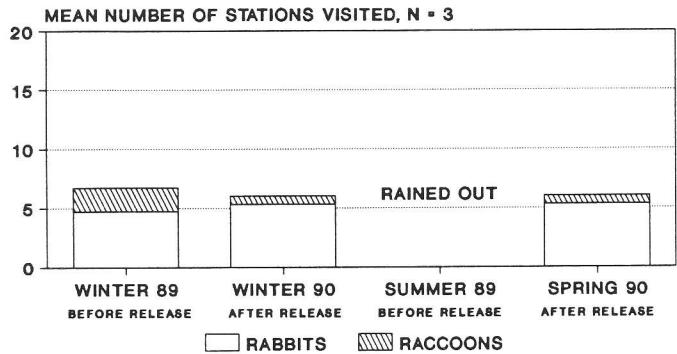


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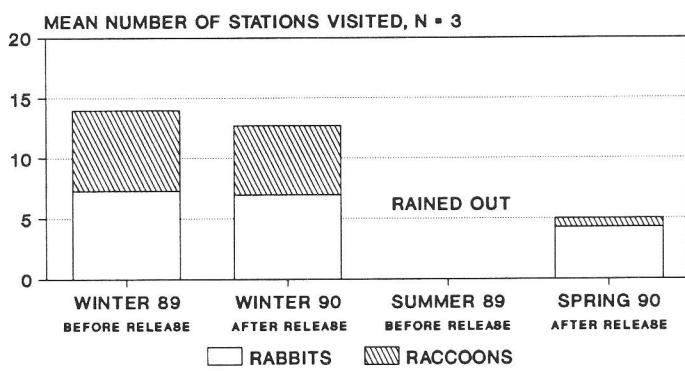
Figure 3. Mean number of baited tracking stations visited in the eastern section.

## EASTERN AREA BAIT STATIONS

### BEACH DUNES



### FOREST



### RELIC DUNES

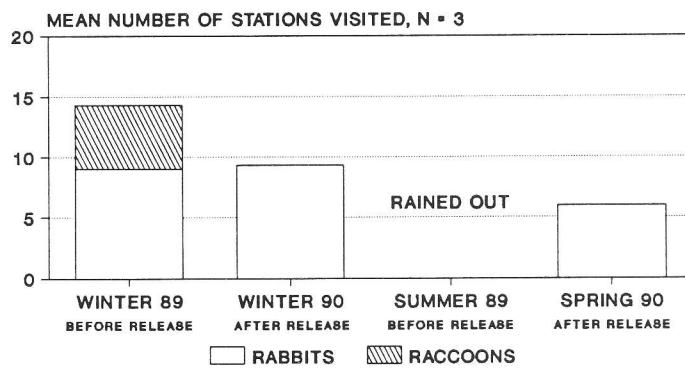
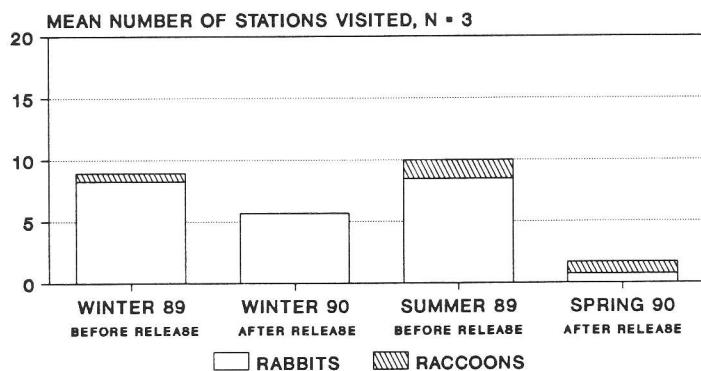


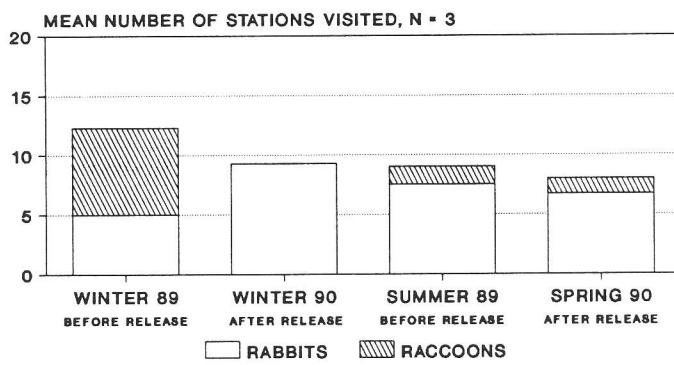
Figure 4. Mean number of baited tracking stations visited in the central section.

## CENTRAL AREA BAIT STATIONS

### BEACH DUNES



### FOREST



### RELIC DUNES

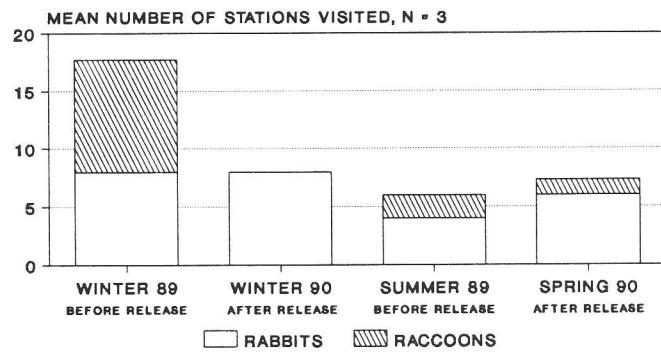
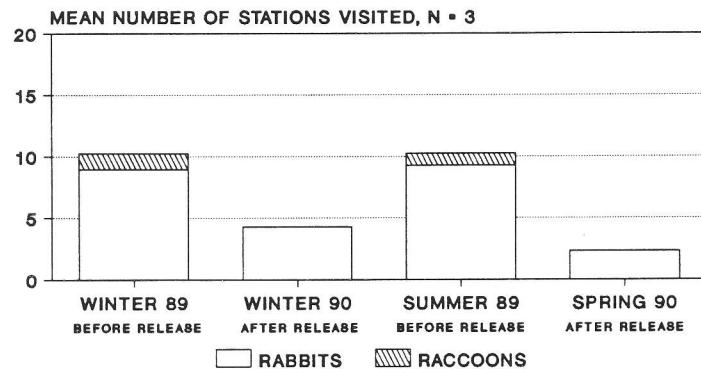


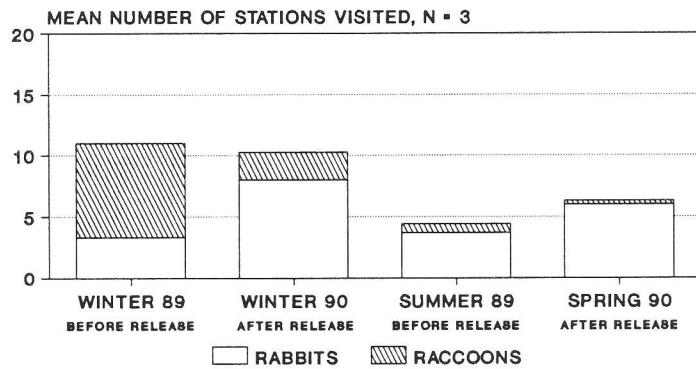
Figure 5. Mean number of baited tracking stations visited in the western section.

## WESTERN AREA BAIT STATION

### BEACH DUNES



### FOREST



### RELIC DUNES

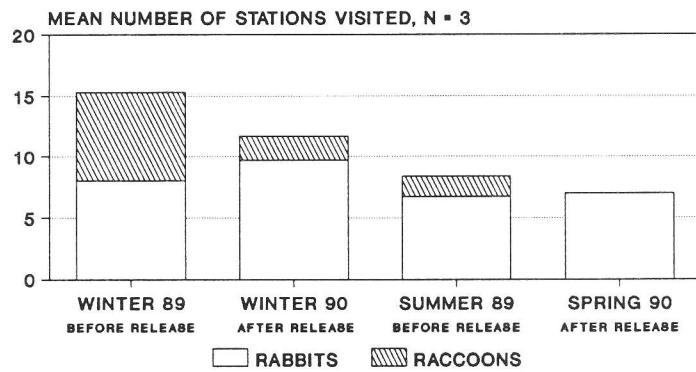
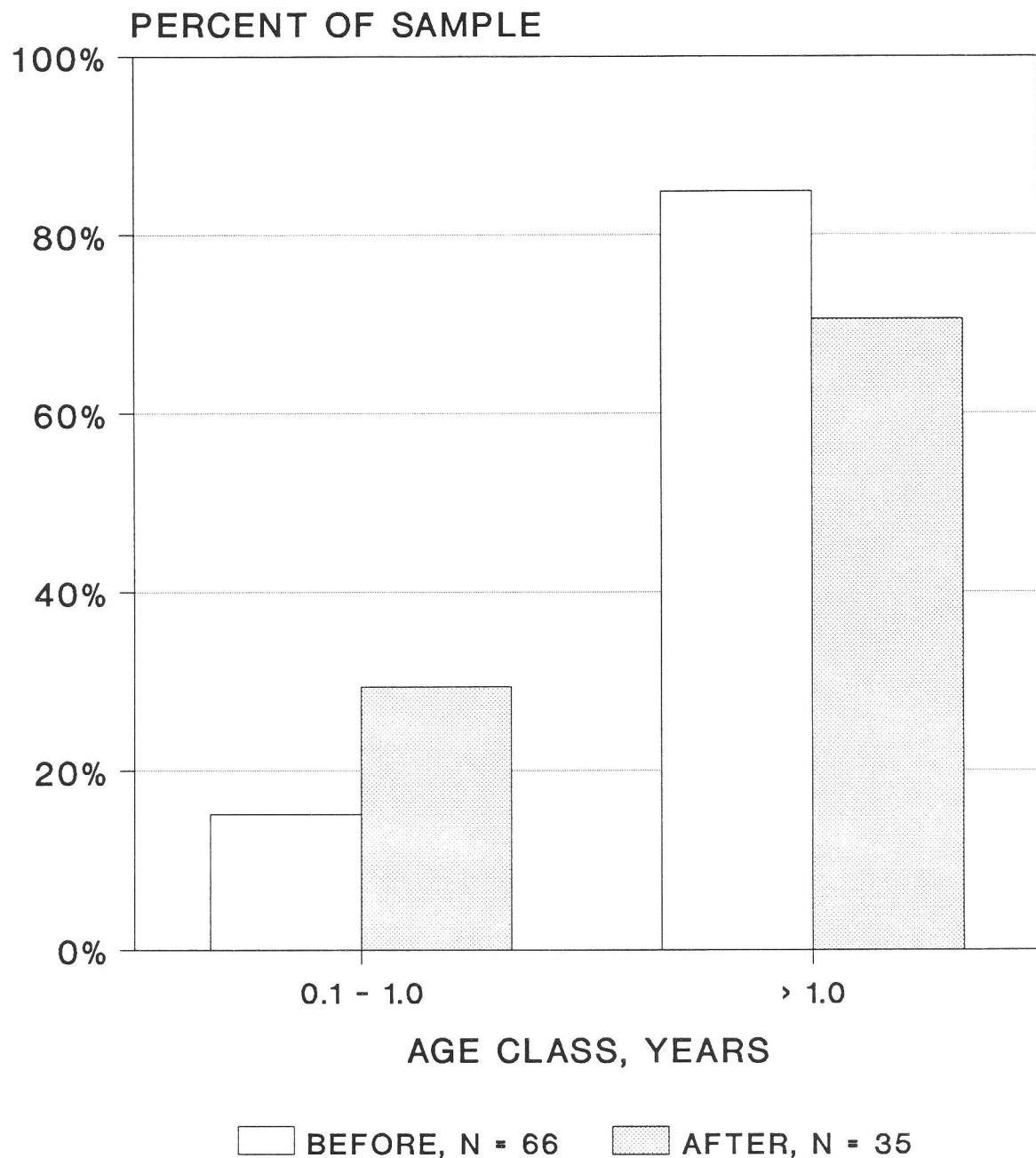


Figure 6. Comparison of age of cottontail rabbits on Horn Island, MS, before and after red wolf release.

# RABBIT AGE STRUCTURE BEFORE AND AFTER WOLF RELEASE



**Figure 7.** Percent of the cottontail rabbits in five age classes before and after red wolf release.

# RABBIT AGE STRUCTURE BEFORE AND AFTER WOLF RELEASE

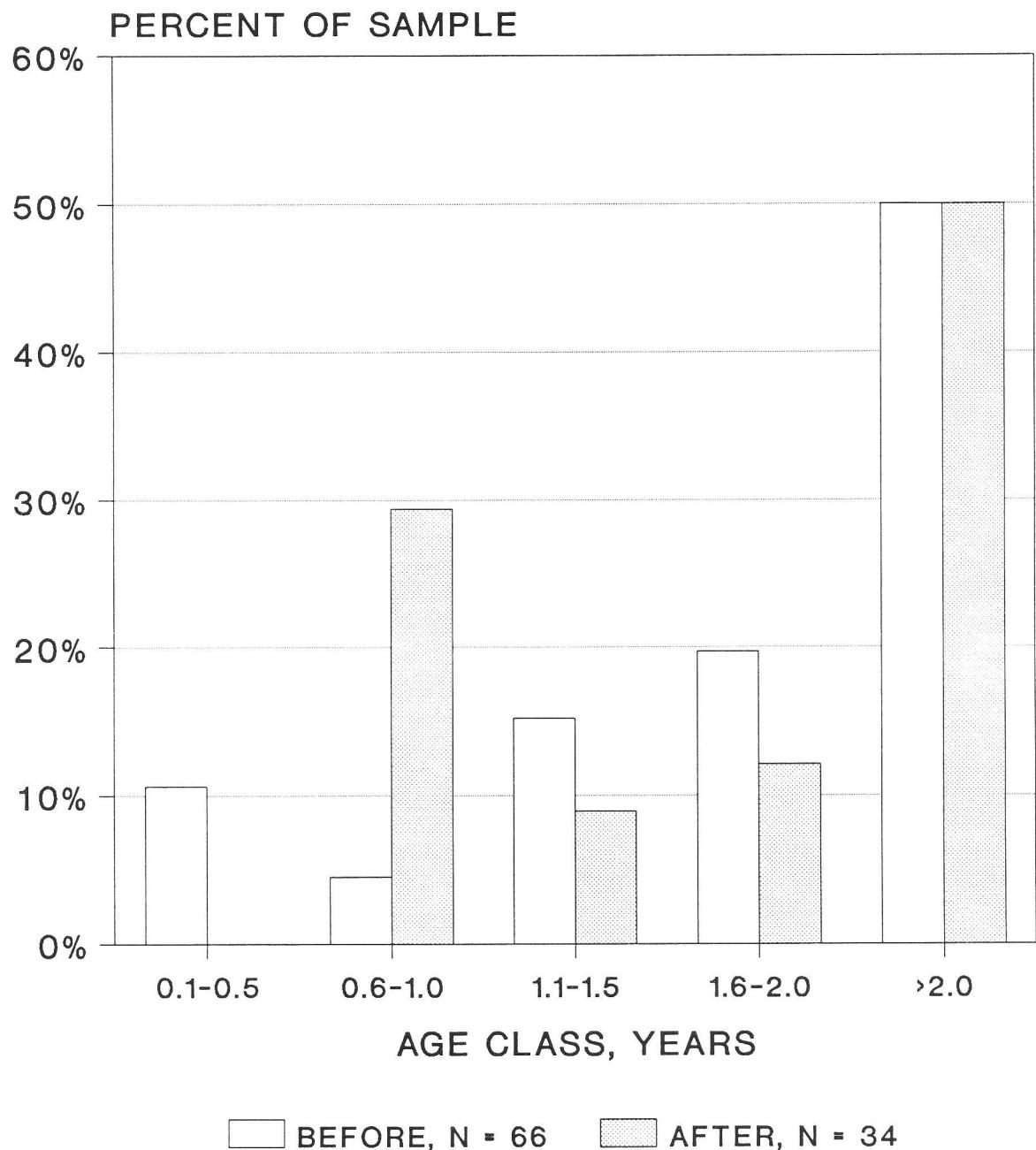


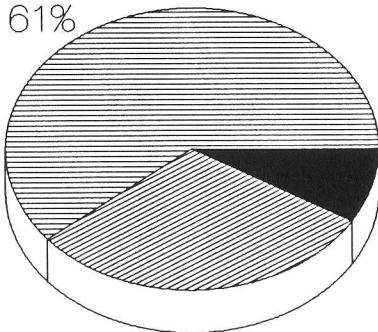
Figure 8. Composition of red wolf diet shortly after release on Horn Island, MS and, after six months.

# RED WOLF DIET

## Horn Island

RABBIT

61%



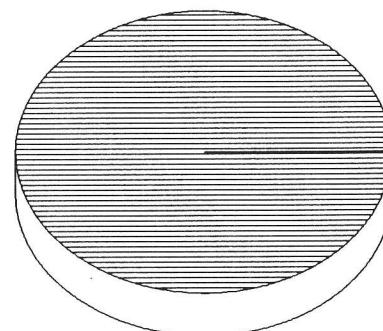
NUTRIA  
9%

RACCOON

30%

AUG - SEP 1989  
(N = 23)

RABBIT  
100%



JAN 1990  
(N = 10)