FINAL REPORT

THE BIOLOGY OF THE GUAM DEER

Pittman-Robertson
Project No. FW-2, Study IV
1961-1978

by
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Territory of Guam
Department of Agriculture
Division of Aquatic and Wildlife Resources

Technical Report No. 3

LIST OF TABLES

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

A Sambar deer (Cervus unicolor) was introduced to Guam from the Philippines during the years 1770 to 1774 by the Spanish Governor Don Mariano Tobias (Safford 1905). This deer became established in the wild on Guam (Quoy and Gaimard 1824) and has since been classified as the Guam deer (Cervus unicolor mariannus) (Lydekker 1915). It has been suggested that the Sambar were brought to Guam from the Philippine Island of Luzon, making the ancestral race C. u. philippinas, however, the evidence is not conclusive (Whitehead 1972).

The Guam deer (Figure 1) has been under investigation by the Division of Aquatic and Wildlife Resources of Guam since 1961. The objective of this deer study was to generate population trend and biological data on which to base management recommendations. Attempts were also made to collect data on morphology, aging, reproduction, food habits and behavior. The purposes of this paper are: to analyse data from 18 years of research on the Guam deer (1961-1978), to assess the current status of knowledge concerning this species on Guam, to ascertain future research needs and delineate future management goals.

The staff of the Division of Aquatic and Wildlife Resources of Guam is acknowledged for the collection of data. This report would not have been possible had it not been for the field efforts of the following biologists: Terry McGowan, Maurice Taylor, Gerald S.A. Perez, Nick Drahos, J. Jeffrey, Ronald Strong, Robert D. Anderson, J. Mark Jenkins and myself. Funding was provided by Federal Aid to Fish and Wildlife Restoration on Guam, Project FW-2, Study IV, Job W2: The Study of the Guam Deer.

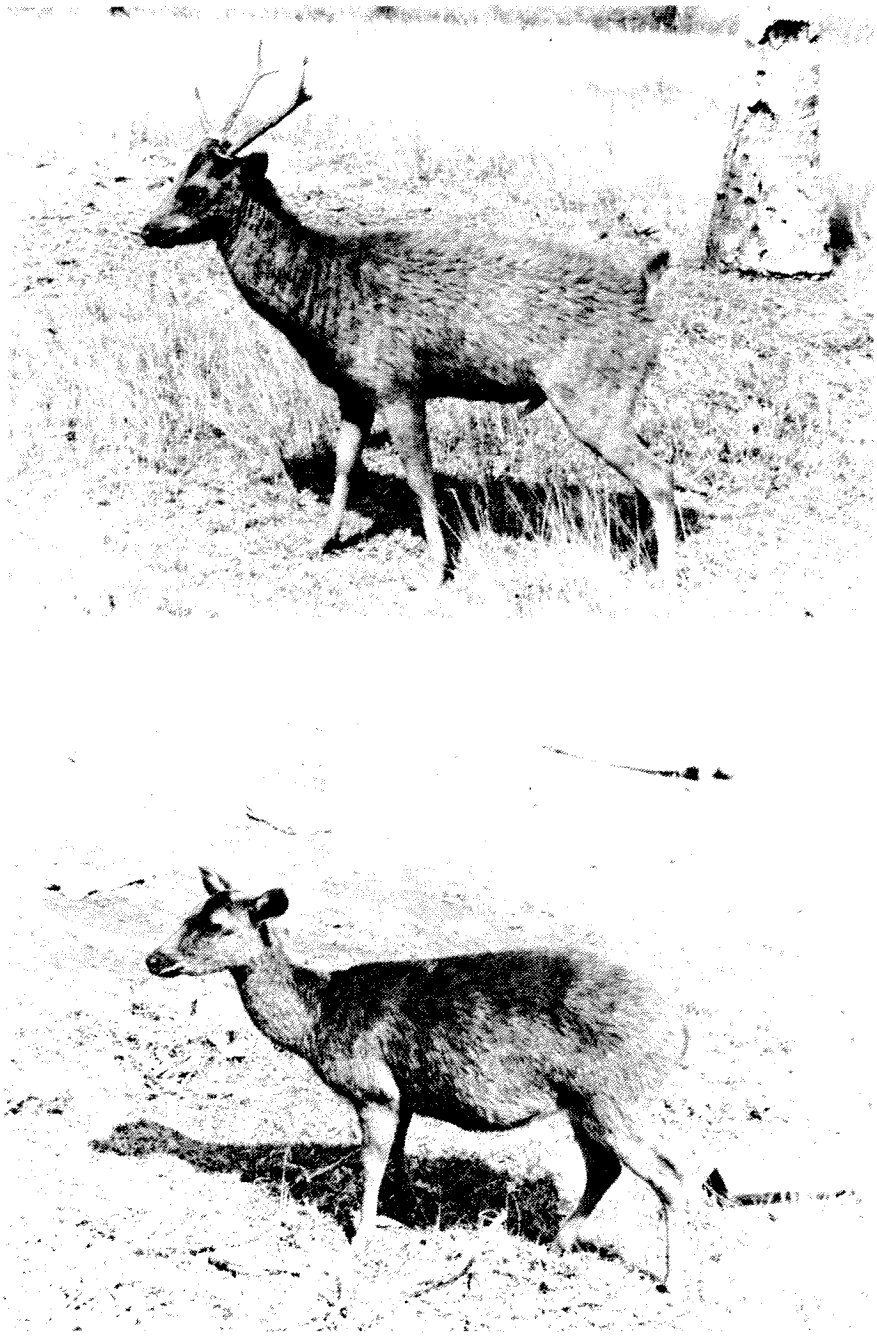

Figure 1. The Guam deer (top: a three-point buck, bottom: a doe).

STUDY AREAS

The Guam deer is found in a number of habitat types, but this deer is most commonly found in forests and forest-grassland ecotones. Of the principal vegetation types described for Guam (Fosberg 1960), those inhabited by deer include forest of elevated hard limestone, ravine forest, grasslands of volcanic soil areas, and areas of herbaceous to shrubby vegetation caused by human disturbance. More detailed treatments of the vegetation types of Guam are available elsewhere (Fosberg 1960, Stone 1970).

The majority of field work on the Guam deer has been conducted on four military installations: Andersen Air Force Base (AAFB), Northwest Field (NWF), the U.S. Naval Magazine (NavMag), and the Naval Communications Area Master Station (NCS).

Andersen Air Force Base

Andersen Air Force Base is located on the upper plateau of northeast Guam. This property includes: a large stand (84 hectares) of coconut (Cocos nucifera) at Tarague Beach; over 931 hectares of relatively undisturbed native forest; large expanses of regularly mowed lawns; and patches of herbaceous and shrubby vegetation. Most of the limestone forest is found in a narrow (.8 Km) belt along the coast that extends from the ocean front up to the upper plateau, which is 152 meters in elevation. Access to AAFB is restricted to military personnel, their dependents, government employees on official business, and persons sponsored onto the base by the military.

Northwest Field

Northwest Field is a large (1113 hectares) expanse of abandoned

runways in northwest Guam that was allowed to revert to a semi-forested condition. This area was originally limestone forest, but several large clearings and patches of shrub communities now exist there, interspersed with some remnant forest. The northern end of Northwest Field (182 hectares south of the cliffline) still supports relatively undisturbed native forest ranging in elevation from 152 meters to 168 meters. Only a few jeep trails provide access to this part of the field. Northwest Field is owned by the U.S. Air Force and access is limited in the same manner as AAFB.

Naval Magazine

Naval Magazine, a storage facility for explosives, is a large expanse of military land (1025 hectares) in south-central Guam consisting of patches of ravine forest interspersed with swordgrass savannah and areas of regularly mowed lawns. In addition, part of Fena Reservoir (71 hectares) is located on the Naval Magazine. Access is restricted to military personnel and government employees on official business. Hunting is not permitted on this property, however, the facility is not fenced and incidents of illegal hunting are common.

Naval Communications Area Master Station

Naval Communications Area Master Station is a Navy owned facility of 936 hectares in Finegayan, on the west coast of Guam. This station has a belt of limestone forest along the coast and patches of forest on the upper plateau which are interspersed with large, mowed lawn antenna fields. Restricted access is similar to AAFB.

PROCEDURES

Night Spotlight Counts

Because of the Guam deer's nocturnal activity patterns, it was necessary to assess its population status through conducting night spotlight counts. A spotlight count required two persons: a driver and a spotter. The route was predetermined and the count was initiated at about one hour after dusk. The driver drove slowly (about 8 kph) while the spotter, seated on the roof of the vehicle, carefully scanned the surrounding area with a spotlight, looking for deer or eyeshine. If eyeshine or deer were observed, the spotter tapped the roof of the vehicle, whereupon the driver stopped the vehicle and the spotter attempted to identify the animals with the aid of binoculars. If the animal was a deer, it was classified, if possible, according to sex and age group. The following age groups were used: fawn, yearling, and adult. Bucks were further classified according to antler development: spike, two-point, three-point, four-point, unclassed buck. A separate category was maintained for deer that could not be sexed or age (unclassified deer). The starting time and mileage and finishing time and mileage were recorded for each count as were weather conditions.

Starting with fiscal year 1964, spotlight counts were conducted monthly at AAFB (7.7 km route average) and NavMag (25.6 km route average), except that no counts were made at either facility in 1973 due to military activities, and monthly counts were not made on NavMag in fiscal years 1970 and 1971. At NCS and NWF monthly counts were made during the fiscal years 1964 through 1967, and infrequent counts were made in 1972 and 1978.

Hunter Reports

From 1969 to 1973 hunting license vendors were requested to have all license buyers complete a hunter report form designed to provide information on the previous year's hunting. This form requested the following information on deer: number of days spent hunting deer, number of deer taken, and number of hours spent hunting deer. From 1974 to 1978 hunters were required to return a hunter report card made available with the purchase of a hunting license and deer tag. In addition to the above information, hunters were asked to report the sex, weight and location of their kill, and if they took a buck, they were asked to report the number of points of the antlers. From these reports, the total number of legal deer hunters was calculated as the product of the percentage of reporting hunters who hunted deer and the number of licensed hunters. The legal hunter kill and number of hunter days were calculated in a similar manner.

Post Mortem Examination

Morphological and reproductive data were collected from the post mortem examination of hunter killed deer and other reported deer mortalities. For the latter, attempts were made to determine the cause of death. The following measurements were made: total length, shoulder height, length of ear from notch to tip, tail length, length of hind foot, and body weight with weight loss due to gunshot bleeding only. In several cases, the weight of the fully dressed carcass was determined. The reproductive tracts of females were examined for fetuses, and in the 1960's digestive tracts were examined for food content.

RESULT AND DISCUSSION

Distribution

The Guam deer is widely distributed over the island, being found as far inland as Tarzan Falls and Conga, at least as far south as Umatac, and as far north as Ritidian Point (Figure 2). This deer has reportedly been taken near urban areas, such as Agana, and in rural areas. The greatest concentrations are, however, found on military land with restricted access and limited or prohibited hunting. These areas include: AAFB, NWF, NCS, and NavMag.

Population Trend - AAFB

During the years 1963 to 1971 the population of deer on AAFB demonstrated an increasing trend as indicated by the annual average number of deer seen per 7.7 km count (Figure 3). Successive odd years were compared using the Mann-Whitney U-test (Sokal and Rohlf 1969). There were significant increases in the population from 1963 to 1965 ($P<.002$), from 1967 to 1969 ($P<.01$), and from 1969 to 1971 ($P<.20$). The maximum count per year increased from 27 deer in 1963 to 189 deer in 1971.

More recently, however, the Andersen deer population has been declining. There was a significant decrease between 1975 and 1977 ($P<.002$), which may be a result of excessive removal of deer from this area during special hunts. The 1978 population level was still significantly lower than the 1975 level ($P<.002$), with a maximum count of 71 deer. Thus, while the Andersen deer population is at a lower level than it was during the first half of this decade, its population is greater than when counts were first initiated in the

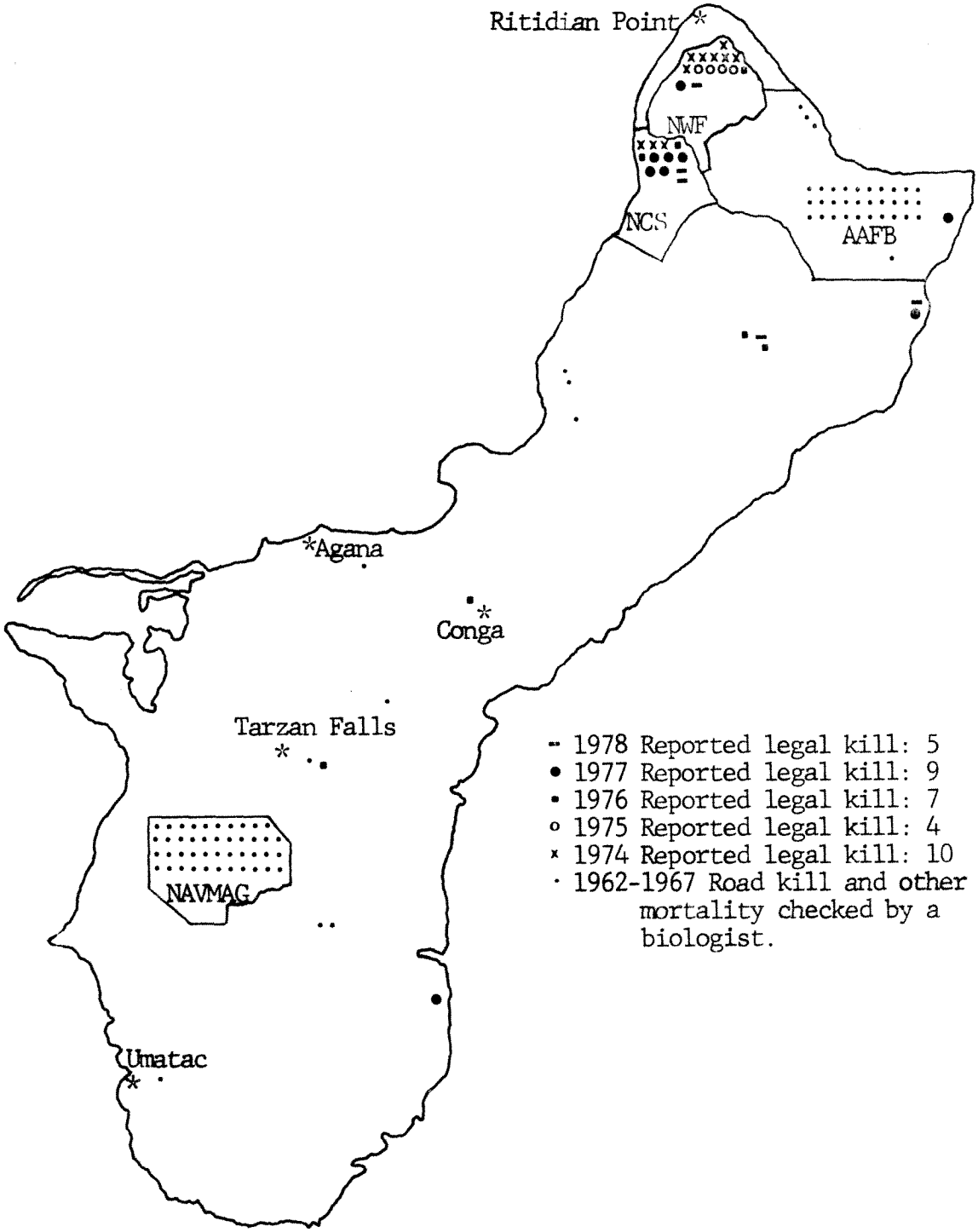

Figure 2. Distribution of the Guam deer.

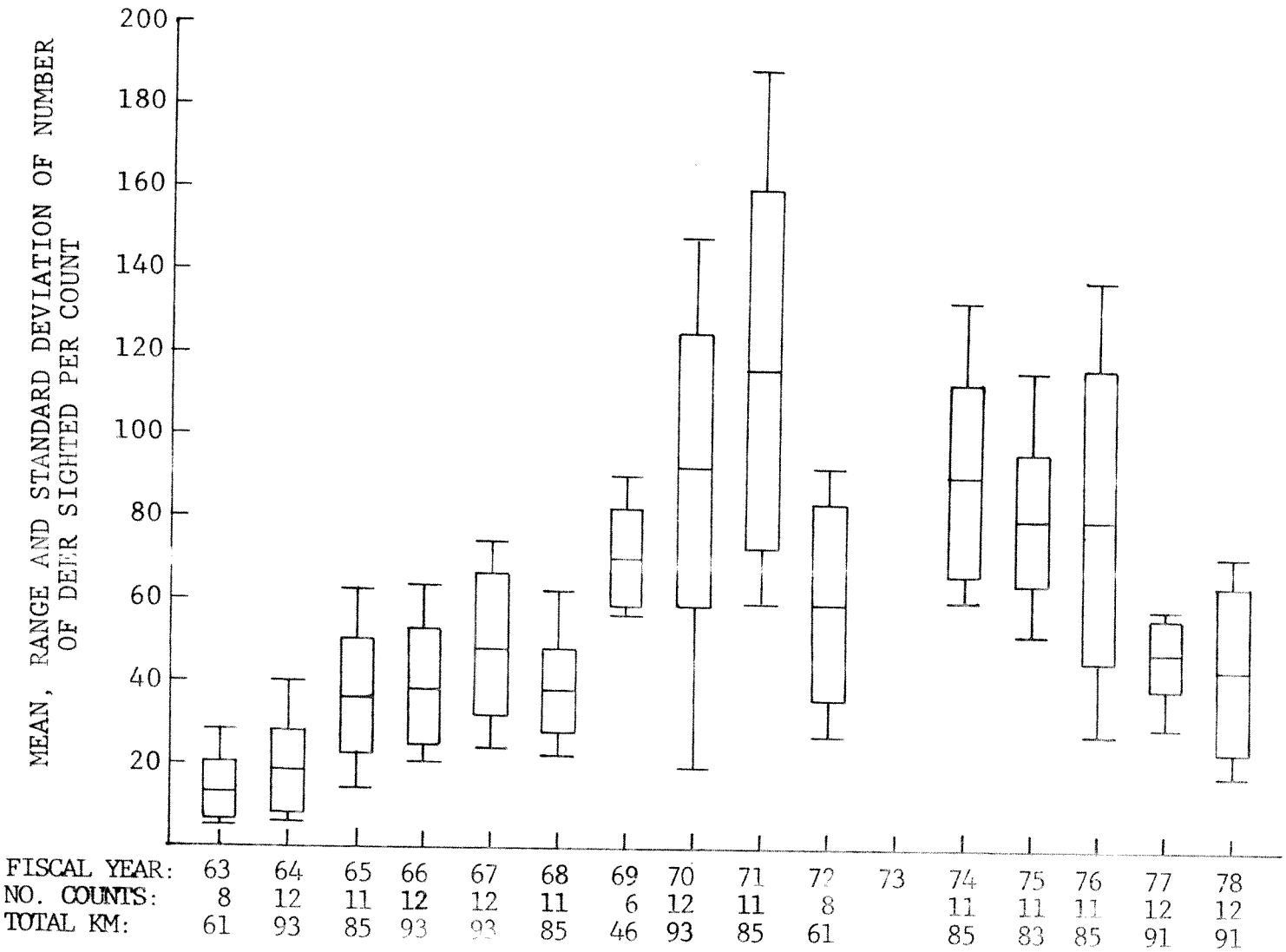

Figure 3. Population trend on Andersen Air Force Base 1963-1978.

1960's.

Population Trend - NavMag

The length of the Naval Magazine deer count varied from 12.8 km to 20.8 km for the years 1964 to 1969 and from 17.6 km to 28.8 km for the years 1972 to 1978. To compensate for this variation, the annual count statistics were figured according to the number of deer sighted per 16 km traveled (Figure 4). Mann-Whitney U-tests were performed on the resulting data to determine if population changes were significant. The population trend on the Naval Magazine was similar to that at AAFB. There were significant increases in the NavMag population from 1964 to 1966 ($P<.01$) and from 1969 to 1972 ($P<.01$). Monthly counts were discontinued in July 1969 and not resumed again until July 1971, so there are no statistics for fiscal years 1970 and 1971. In addition, no counts were conducted in 1973 due to increased security mandated by the Vietnam War. However, from 1972 to 1974 there was a significant decrease in the population ($P<.10$), with the count mean decreasing from 69 deer per 16 km to 50 deer per 16 km. The 1975 population was still significantly lower than 1972 ($P<.10$). The population continued to decline between 1974 and 1976 ($P<.002$) and has not significantly increased through 1978.

Population Trend - NCS and NWF

During the mid-1960's deer were relatively abundant on the Naval Communications Station and Northwest Field. As many as 115 deer and 22 deer per 16 km traveled were counted in these two areas respectively (Figures 5 and 6). More recently the counts have been much lower, with at most one or two deer seen on a typical count. These

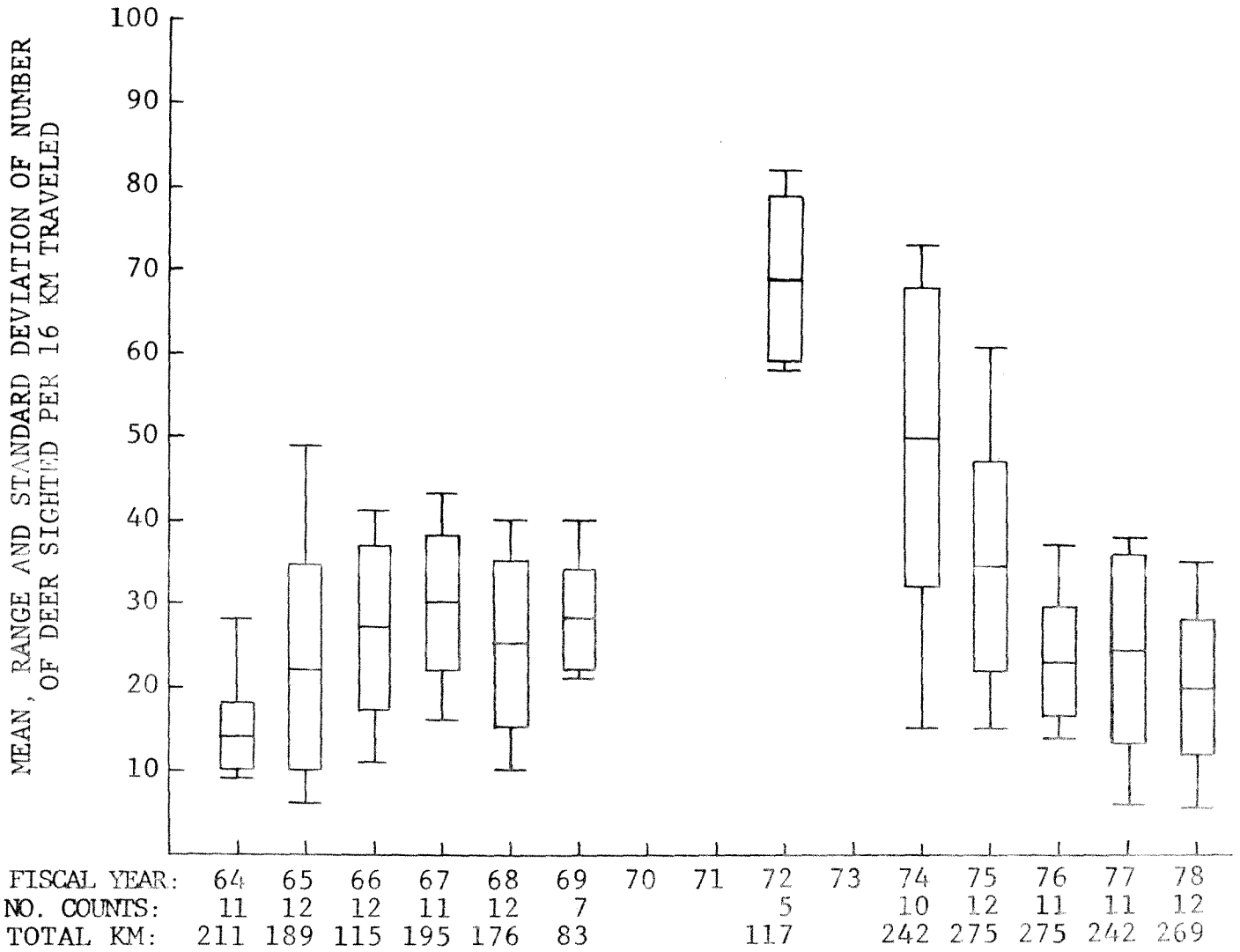

Figure 4. Population trend on the U. S. Naval Magazine 1964-1978.

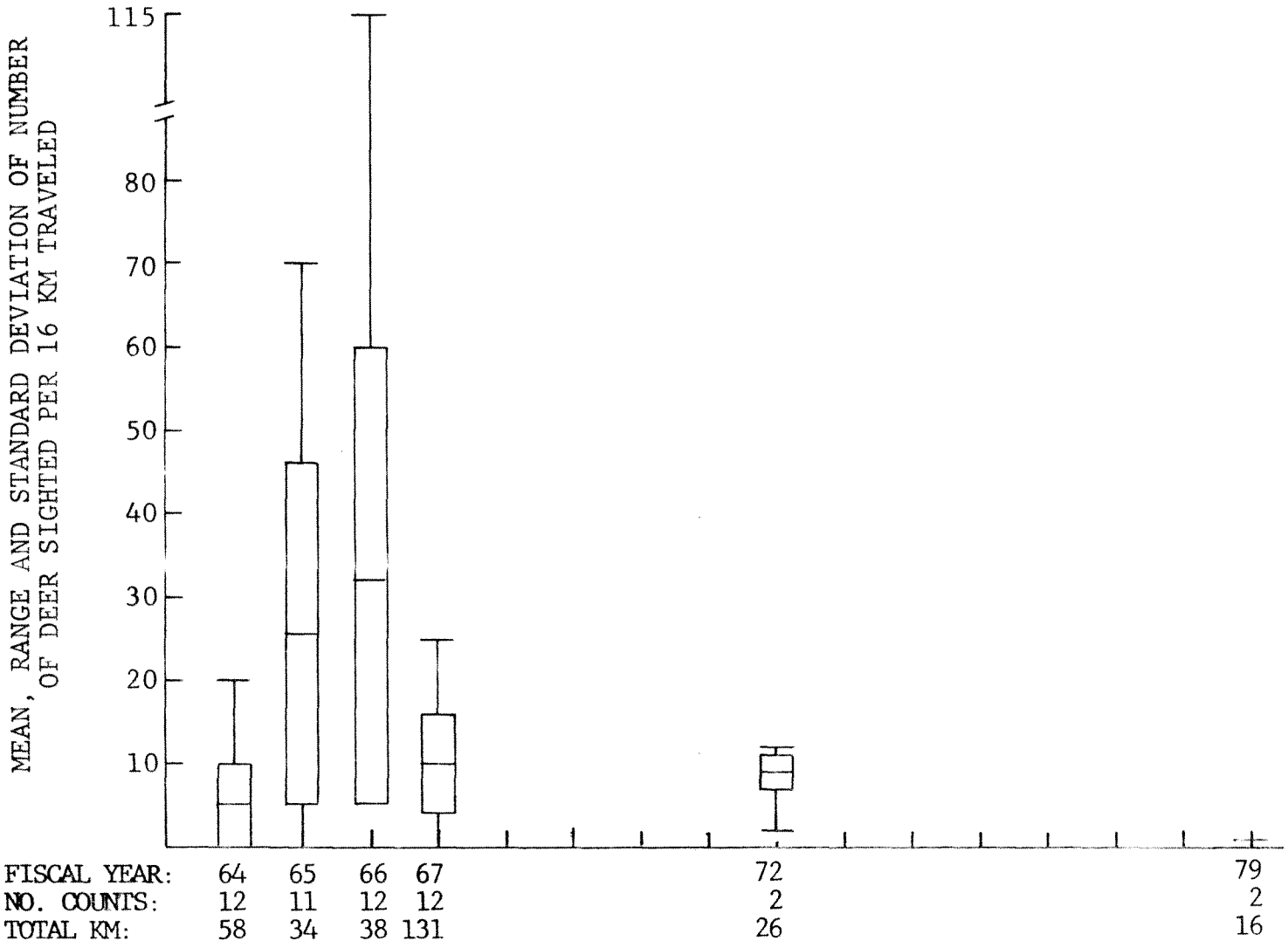

Figure 5. Population trend on the Naval Communications Area Master Station 1964-1979.

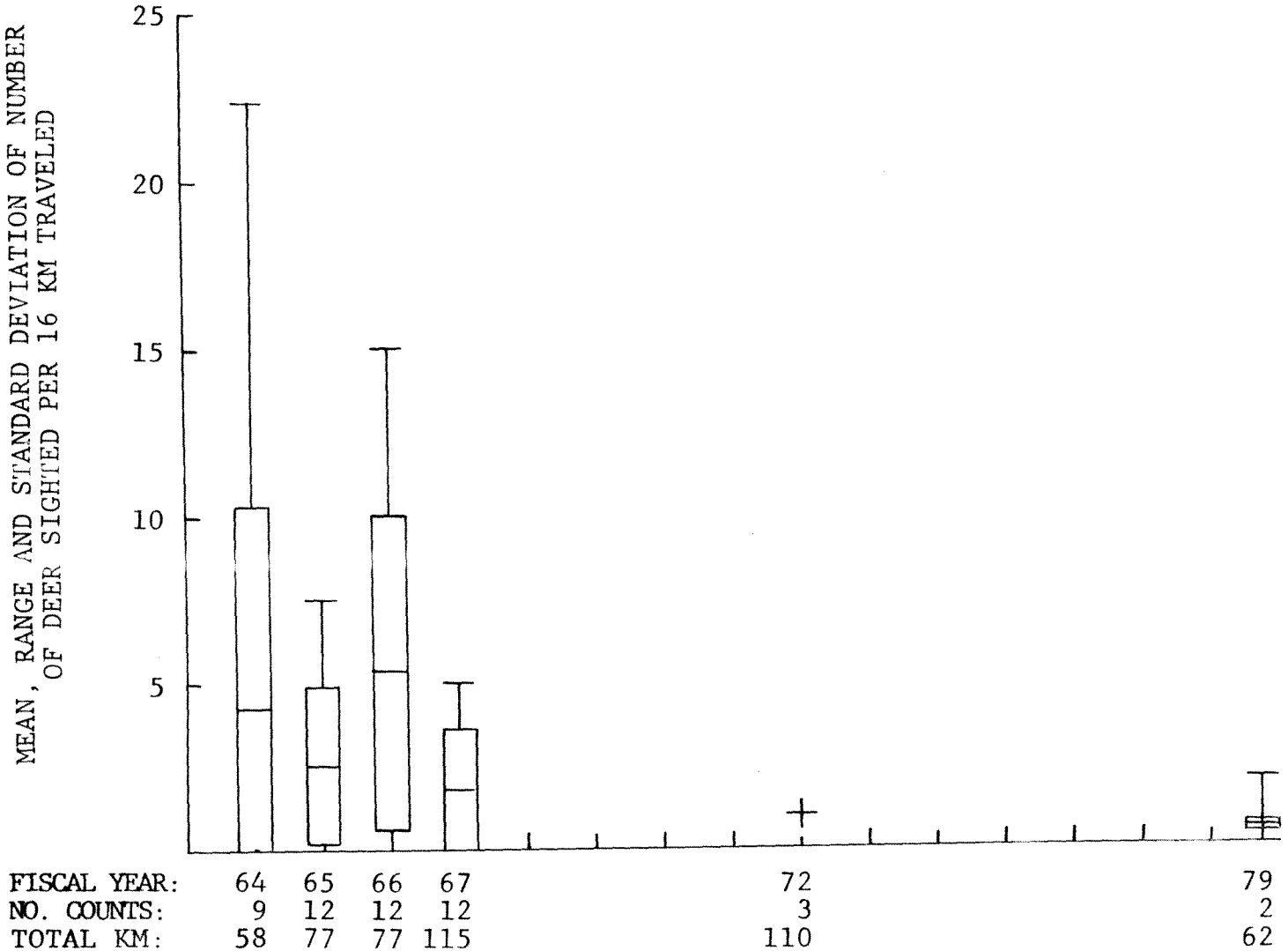

Figure 6. Population trend at Northwest Field 1964-1979.

two areas now have extremely low deer populations and it is likely that over-hunting (both legal and illegal) has been the cause.

Composition

The percentages of deer in each age and sex category have varied somewhat from year to year between 1964 and 1978 (Tables 1 and 2). For the AAFB deer herd the mean percentages of identified deer over this period were: 25.9% bucks, 45.8% does, 13.7% yearlings and 12.1% fawns; while the mean fawn to doe ratio was 1:4.1. The most recent year's data (1978) suggest that the proportion of bucks is below average, while the proportion of does is above average. The possibility of the introduction of bias exists due to the fact that bucks that have recently shed their antlers may be classed as does, introducing a negative bias to the buck class and a positive bias to the doe class. The Guam deer may drop their antlers at any time of the year, as opposed to deer of temperate regions, which carry their antlers only during a restricted season. For this reason it has not been possible to eliminate the bias. The percentage of hunter-killed bucks with no antler development showing (from either sex hunts) was 4% of bucks (see below - Antlers). As a consequence, the buck class may be a few percentage points below actual and the doe class may be a few percentage points above actual.

For the NavMag deer herd, the mean percentages were: 27.3% bucks, 50.5% does, 11.3% yearlings and 10.9% fawns; while the mean fawn to doe ratio was 1:5.2. In the long run it appears that the NavMag herd has had a greater proportion of adults in the population than AAFB, even though both herds have had similar population trends.

Table 1. Composition of the Andersen Air Force Base Deer Herd.

Fiscal Year	Percentage of Deer Identified	Percentage of identified deer in each class				Fawn - Doe Ratio
		Bucks	Does	Yearlings	Fawns	
1964	62.8	37.9	33.6	18.9	9.4	1:3.6
1965	58.0	31.4	35.0	20.7	9.0	1:3.9
1966	60.1	25.8	43.1	25.1	6.0	1:7.2
1967	61.0	27.7	37.8	6.2	8.3	1:4.6
1968	73.2	27.5	55.6	0	13.7	1:4.1
1969	68.2	29.3	44.0	11.6	15.1	1:2.9
1970	61.0	28.4	44.1	13.1	14.4	1:3.1
1971	50.1	29.9	42.6	12.6	13.4	1:3.2
1972	50.4	33.9	34.3	11.5	20.2	1:1.7
1974	58.6	17.0	51.2	15.2	16.6	1:3.1
1975	58.9	17.8	57.0	15.6	8.1	1:7.0
1976	60.6	21.1	53.3	13.0	12.9	1:4.1
1977	63.5	22.4	52.7	13.2	11.7	1:4.5
1978	57.4	16.6	56.5	15.3	11.0	1:5.1
Mean	60.3	25.9	45.8	13.7	12.1	1:4.1

Table 2. Composition of the Naval Magazine Deer Herd.

Fiscal Year	Percentage of Deer Identified	Percentage of identified deer in each class				Fawn - Doe Ratio
		Bucks	Does	Yearlings	Fawns	
1964	86.2	30.9	45.1	19.7	4.3	1:10.5
1965	86.5	35.9	47.4	6.1	10.4	1: 4.6
1966	81.3	33.8	46.5	10.3	9.3	1: 5.0
1967	80.7	30.2	53.3	7.3	9.2	1: 5.8
1968	89.4	25.7	56.0	5.0	13.4	1: 4.2
1969	93.1	17.8	54.9	5.3	16.6	1: 3.3
1972	56.3	27.9	40.8	17.0	14.0	1: 2.9
1974	69.6	19.8	50.3	17.5	12.8	1: 3.9
1975	71.6	19.6	58.5	13.8	8.1	1: 7.2
1976	59.3	28.2	55.1	7.8	11.3	1: 4.9
1977	62.5	37.0	54.2	8.2	8.2	1: 6.6
1978	70.9	21.4	44.3	17.1	13.4	1: 3.3
Mean	75.6	27.3	50.5	11.3	10.9	1: 5.2

Annual fluctuations in the proportional numbers of deer in each age and sex class are difficult to explain without more detailed information on mortality, behavior, and movement patterns. Annual fluctuations in herd composition could be the result of differential mortality or they could be due to small group emigrations from a given locality. All hunter mortality in the NavMag herd has been the result of illegal hunting, so sex and age class information on those kills is not available. While some legal hunting has taken place on AAFB over these years, illegal hunting takes place there as well, consequently, the causes of the skewed herd compositions must remain speculative.

Hunting

Licensed deer hunting was initiated on Guam in 1964. From 1968 to 1972 there were two deer hunting seasons on Guam: one from the second Saturday in March to the second Sunday in May and one from the second Saturday in November to the third Sunday in December. The season limit for these years was two deer, only one of which could be a doe. In 1973, the spring season was discontinued and a fall season from October 1 to December 31 was established. In addition, the season limit was changed in 1973 to one deer of either sex but no deer under 18 kg. In 1978, at the recommendation of the Division, the Government established a further restriction that only antlered deer may be taken.

Hunter reporting procedures were initiated for the 1968 seasons, and they were carried on continuously thereafter. The calculated hunter statistics (Table 3) were determined from replies given by reporting hunters, and it is assumed that reporting hunters are a

Table 3. Island-wide Hunting Statistics 1968-1977

YEAR	Calculated No. Legal Deer Hunters	Percentage of Returned Reports	Calculated Legal Take	Calculated Hunter Days	Hunter Success (%)	Mean No. Days Per Hunter	Hunter Days Per Deer Taken
1968	320	15.2	105	2,240	31	7.0	21.3
1969	614	7.0	507	4,912	35	8.0	9.7
1970	472	6.0	304	5,758	46	12.2	18.9
1971	657	5.0	175	5,847	19	8.9	33.4
1972	335	9.0	98	2,177	29	6.5	22.2
1973	295	13.8	104	3,688	25	12.5	35.5
1974	349	11.3	109	1,640	31.9	4.7	15.0
1975	348	10.3	61	2,297	17.6	6.6	37.6
1976	285	8.8	91	1,482	32.0	5.2	16.3
1977	170	14.3	78	1,164	44.8	6.8	14.9

sample representative of all legal deer hunters. The calculated legal kill was very high in 1969 (507 deer) and 1970 (304 deer), but has been within the range of 60-110 deer for the past six years (1972-1977). The most recent trend (1975-1977) has been a decrease in the number of legal hunters and hunting effort (total hunter days) with a concurrent increase in hunter success.

Special Hunts

Special hunts to take deer on AAFB were initiated at the request of Air Force personnel in August 1968. These hunts were held during the morning daylight hours of the last weekend of every month and they were held continuously through April, 1971. The purpose of the hunts was to decrease the number of deer in the runway areas of the air base because such deer were presenting a safety hazard to aircraft. From June 1971 to January 1972, the hunts were held every other month, and thereafter they were temporarily discontinued due to increased military activities resulting from the Vietnam War. The special hunts were resumed in July 1974, with a total of 22 hunt days held the following fiscal year and 20 hunt days during fiscal year 1976. No hunts were held in fiscal year 1977 because it was felt that deer numbers were adequately depressed in the hunt area. Hunts were again held monthly in fiscal year 1978.

These special hunts were coordinated through the Air Force base game warden; and the Taotaomona Rod and Gun Club, a military sports club, sponsored all local civilians who wished to participate in these hunts, providing they complied with military and government regulations. A summary of special hunt statistics (Table 4) indicates decreasing trends in mean weights of both bucks and does, suggesting that a

Table 4. U.S. Andersen Air Force Base Special Hunt Statistics, FY 1969-1978

Fiscal Year	No. of Hunts	No. of Hunters			Total Deer Take, Weights and Means									
		Gun	Bow	Total	No. of Bucks	Weight Range (lbs.)	Mean Wt. (lbs.)	No. of Does	Weight Range (lbs.)	Mean Wt. (lbs.)	Total Deer	Total Wt. (lbs.)	No. Hunters/ Deer Taken	Hunter Success
1968-69	17	489	14	503	48	32-225	123.0	51	18-150	82.6	99	10,117	5.1	19.7%
1969-70	18	689	60	749	53	30-220	98.3	48	30-120	73.8	101	8,752	7.4	13.5%
1970-71	22	751	68	819	53	18-180	95.8	41	20-125	77.7	94	8,263	8.7	11.5%
1971-72	6	177	8	185	17	30-185	83.8	9	35-100	73.9	26	2,090	7.1	14.1%
1972-73	2	65	0	65	4	60-154	102.3	5	42-95	71.4	9	766	7.2	13.8%
1974-75	22	696	111	807	57	16-170	97.4	50	11-115	66.9	107	8,897	7.5	13.3%
1975-76	20	689	104	793	69	15-185	86.8	90	15-105	68.7	159	12,172	5.0	20.1%
1977-78	24	519	36	555	24	40-145	84.0	33	25-120	66.1	57	4,198	9.7	10.3%

greater percentage of the population may be younger animals. In addition, the percentage of successful hunters for fiscal year 1978 was the lowest of any year for these hunts. For these reasons the special hunts were discontinued in July 1978 until such time as it becomes necessary to remove deer from this area for safety or biological reasons.

Night Hunting

Night hunting by permit was allowed during the fall 1969 season and the spring seasons of 1970 and 1971. The objectives of these hunts were to: 1) allow legitimate hunters to take some of the deer that were constantly being harvested by illegal hunters; 2) permit the staff to meet and talk on a friendly basis with several known illegal hunters as a prelude to reducing the incidence of illegal deer hunting; and 3) to obtain biological data that would be difficult to obtain in any other way. Night hunters were limited to three hours of hunting, from 7:00 p.m. to 10:00 p.m., on either the Naval Communications Station or Northwest Field. Hunters were required to hunt in pairs and each pair was monitored by a pair of Conservation Officers or Security Police. Hunter success (Table 5) was not any greater than that of the regular deer hunting season, however, the effort required to take a deer was somewhat less. It is doubtful that the night hunts fulfilled the objective of converting illegal night hunters to legal daytime hunters, as the illegal hunting problem on Guam has not diminished since these night hunts. The night hunts did provide data that may be useful towards determining the relative success of illegal night hunters.

Annual Cycles

In cervids of temperate North America investigators have reported restricted periods for mating and for the drop of fawns (Taylor 1956).

Table 5. Night Hunting Statistics 1969-1971

SEASON	Fall 1969	Spring 1970	Spring 1971
No. of Hunter Pairs	23	62	82
Total Man-Hours	100.5	387	492
No. of Successful Hunter Pairs	4	11	27
No. of Deer Taken	4	12	27
Percentage of Successful Pairs	17.4	17.7	16.0
Man-Hours/Deer Taken	25.1	32.2	18.2
Man-Nights/Deer Taken	8.4	10.7	6.1

During the rut cycle bucks are more active and spend a greater amount of time near groups of does. Theoretically, the result of synchronous buck rut cycles would be an increased probability of seeing a buck during the rut period. The mating period of mule deer (Odocoileus hemionus) is usually November through January and fawns are dropped in June and July (Einarsen 1956). Similarly, for the white-tailed deer (Odocoileus virginianus) breeding peaks at about mid-November and the corresponding peak drop of fawns is in June (Severinghaus and Cheatum 1956). For the North American elk (Cervus canadensis) the active rutting season extends from the first part of September to the latter part of October, and the period of calving is generally May to June (Murie 1951). According to one theory, however, the sexual rhythm of cervids is established by seasonal factors varying with latitude and affecting antler and sex gland development by way of the pituitary (Wislocki 1943). According to this theory seasonal changes in light intensity and temperature provide the necessary stimuli to elicit the onset of the breeding season. It follows from this theory that deer of tropical area (with less seasonal variation in light intensity and temperature) would have a less well defined breeding season.

The Sambar deer as a group have a very variable breeding season. In India most Sambar shed their antlers in March or April, but in Burma shedding takes place between May and July, while in the Malayan peninsula there does not seem to be any well defined breeding season and stags with hard antlers can be seen at times with those in full velvet (Whitehead 1972).

Spotlight count and hunter kill data suggest that the Guam deer does not have a distinct breeding season. Bucks in velvet have been

noted every month of the year (Table 6) and make up five to ten percent of the total bucks counted. Furthermore, the percentage of identified deer that were bucks remained at a fairly constant level (20.0% ± 6.7%) throughout the year (Figure 7). Similarly, fawns were sighted in every month of the year (Figure 8) and make up a fairly constant percentage of the population (11.75% ± 4.9%) for all months. Kill data from the special hunts at AAFB (Table 7) show that pregnant does were taken during every month of the year with a monthly mean of 55.6% pregnant and a standard deviation of 17.3%. In conclusion, the Guam deer has no distinct breeding season and in fact breeding takes place the year-round and appears not to be synchronously timed to environmental factors.

Social Grouping

In many cervids social organization is limited to the family group, which often consists of an older doe with her fawns and sometimes her previous year's offspring (Taylor 1956). During the breeding season, such groups may be accompanied by one or more bucks. In the Guam deer, small groupings are also common. During the fiscal years 1969 and 1970 accurate records were kept of the social groupings of all deer sighted in night spotlight counts (Table 8). Deer were considered grouped if they were within nine meters of another deer. Although most (52.2%) of the sightings were of single deer, groupings of two, three, four or five deer were common. Of these groupings, most (63.3%) consisted of deer of mixed age groups, but there was also a small number of groups made up of adults only. Bachelor groups were much less common than mixed sex or all doe groups. It appears likely that the social organization of the Guam deer is also limited to the family group, although further study of behavior and marked deer would be required

Table 6. Summary of Bucks in Velvet Killed At AAFB Special Hunts (1969-1976), Contrasted With Velvet Bucks Seen In Spotlight Counts (1963-1976).

Month	AAFB Special Hunts			Spotlight Counts (AAFB & Naval Magazine)			Total*		
	Total Bucks	Total Bucks in Velvet	Percent Velvet	Total Bucks	Total Bucks in Velvet	Percent Velvet	Bucks	Velvet	Percent Velvet
January	14	2	14.3	204	20	9.8	218	22	10.1
February	31	9	29.0	167	6	3.6	198	15	7.6
March	39	11	28.2	150	10	6.7	192	22	11.5
April	8	1	12.5	189	14	7.4	208	19	9.1
May	8	1	12.5	152	8	5.3	160	9	5.6
June	15	2	13.3	157	13	8.3	172	15	8.7
July	12	0	0	234	19	8.1	246	19	7.7
August	29	10	34.5	249	18	7.2	278	28	10.1
September	16	8	50.0	210	13	6.2	226	21	9.3
October	18	5	27.8	223	20	9.0	241	25	10.4
November	26	14	53.8	207	23	11.1	235	39	16.6
December	43	13	30.2	301	23	7.6	341	36	10.5

* Also includes some night hunt data.

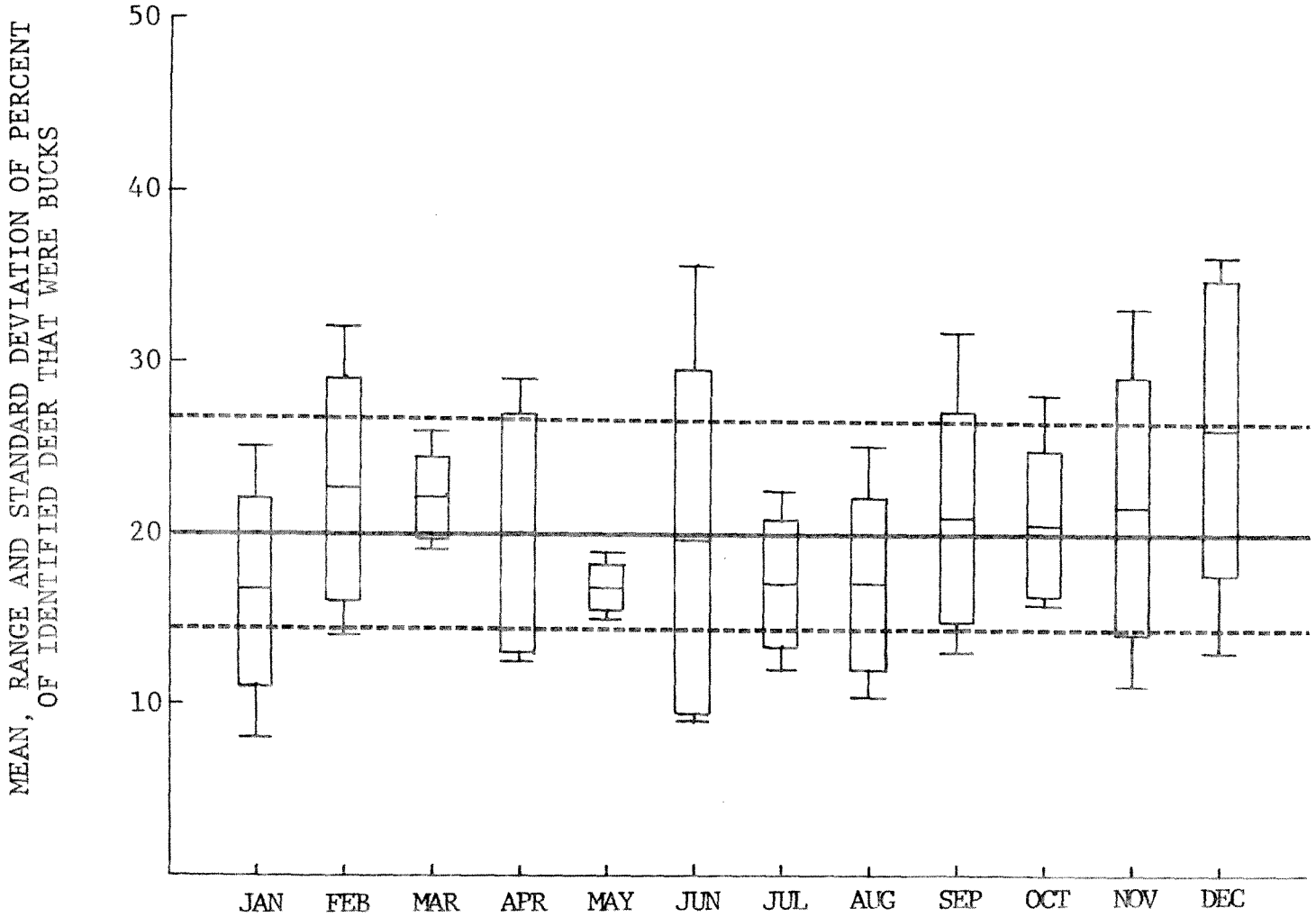

Figure 7. Percentage of identified deer that were bucks (1974-1978 spotlight counts on AAFB and NavMag combined). Continuous horizontal line represents the overall mean, while dashed lines represent the overall standard deviation.

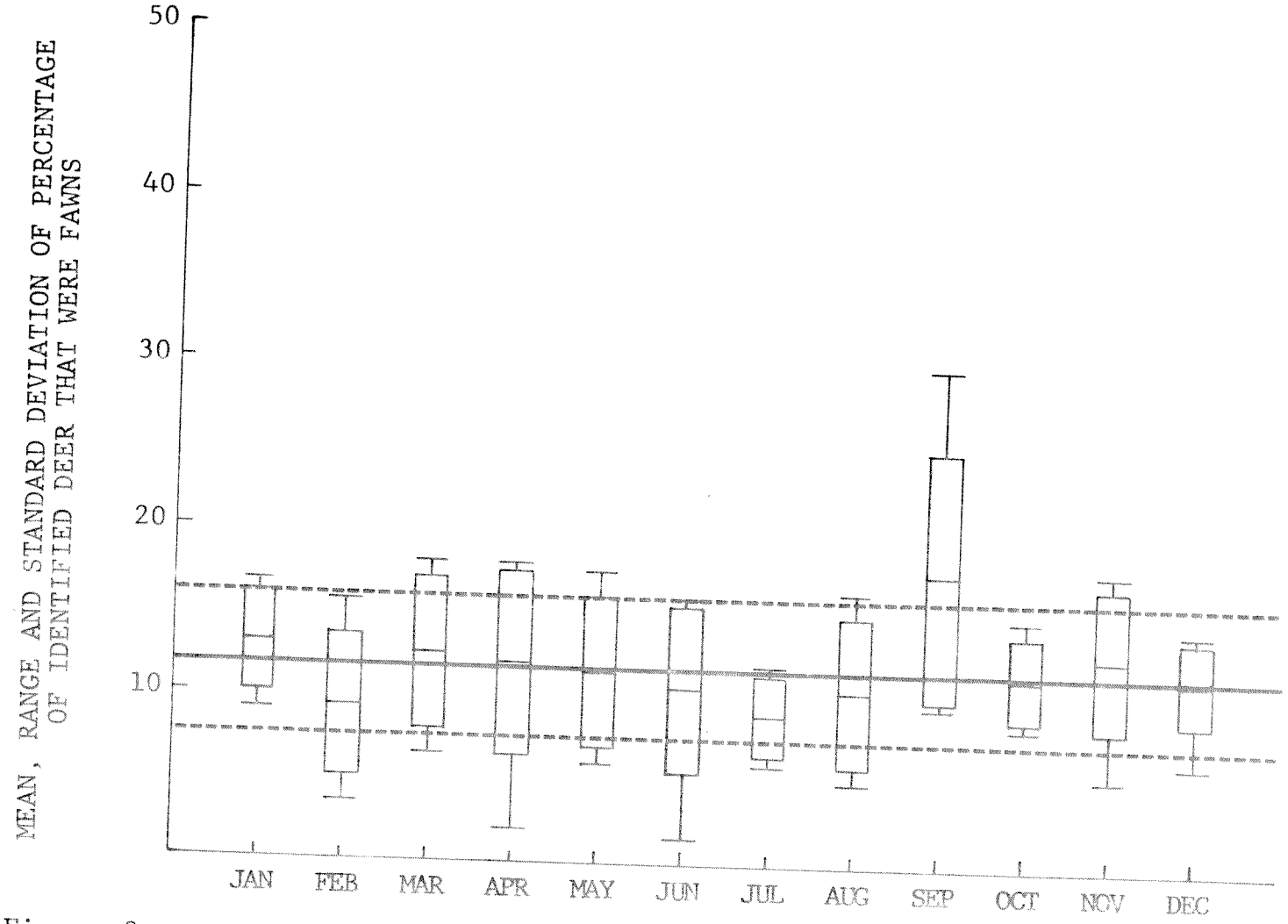

Figure 8. Percentage of identified deer that were fawns (1974-1978 spotlight counts on AAFB and NavMag combined). Continuous horizontal line represents the overall mean, while dashed lines represent the overall standard deviation.

Table 7. Percentage of Does Pregnant in Accumulated Deer Kills During Special Hunts at AAFB (1968-1974)

Month	Total No. Does Taken	No. of Does Pregnant	Percentage of Does Pregnant
January	7	4	57.1
February	17	10	58.8
March	17	12	70.6
April	7	4	57.1
May	12	8	66.7
June	22	12	54.5
July	9	5	55.6
August	16	11	68.8
September	9	3	33.3
October	9	1	11.1
November	5	4	80.0
December	13	7	53.9

Table 8. Social groupings in fiscal years 1969 and 1970 from combined counts at AAFB and NavMag.

GROUP SIZE	No. Groups of Does Only	No. Groups of Bucks Only	No. Groups with Bucks & Does but no Young	No. Groups with Does and Young, but no Bucks	No. Groups with Bucks Does, and Young	No. Groups with Unident-ified Deer	Total No. Deer in each Group Size	Percentage of all Deer Sighted
Single	-	-	-	-	-	-	801	52.5
2	8	11	13	40	-	64	272	17.8
3	4	-	12	11	11	41	237	15.5
4	2	-	-	7	7	12	112	7.3
5	1	-	-	1	2	12	80	5.2
6	-	-	-	-	-	1	6	.4
7	-	-	-	-	-	1	7	.5
12	-	-	-	-	-	1	12	.8
Total Deer In Category	41	22	62	146	71	384	1,527	
Percent of All Deer	2.7	1.4	4.1	9.6	4.6	25.1		
Percent of Identified and Grouped Deer	12.1	6.3	18.3	42.8	20.5			

to verify this assumption.

Mortality

A record was kept of all reported and investigated deer mortalities occurring in fiscal years 1965, 1966 and 1967 (Table 9). Apart from man, the principle predators of mainland Sambar include leopard, jackal, tiger, python and crocodile. On Guam all these predators are lacking and man is the principal cause of mortality. Hunting (both legal and illegal) accounted for 66.5% of all known mortality, while other factors were of lesser importance. While there is no recent detailed accounting of all mortality factors, it is still very likely that hunting accounts for the great majority of all mortality. Road kills are less frequently reported than in the 1960's, but feral dogs are still somewhat common in the two major areas occupied by deer (AAFB and NavMag). In fiscal year 1978, AAFB security police initiated a feral dog trapping program and NavMag security had a policy of dispatching feral dogs on the Magazine. These programs may decrease the presence of feral dogs in prime deer areas but feral dogs are common throughout the island and could move in from neighboring areas.

Although there is no accurate estimation of the mortality due to illegal hunting, it has been reported by security police that illegal night hunting activities occur every weekend all year long. For this reason it is suspected that illegal hunting mortality is probably greater than legal hunting mortality, and if so it would be the greatest mortality factor.

Weights and Measurements

The Samber of the Philippines are relatively smaller in stature than conspecific deer of the Asian mainland. The smallest (C. u. nigricans)

Table 9. Causes of known deer mortality for Fiscal Years 1965 through 1967.

Cause of Mortality	No. of Mortalities	Percentage of Total	Percentage of Determined Cause
Legal Hunting	105	55.0	60.7
Road Killed	22	11.5	12.7
Illegal Hunting	22	11.5	12.7
Undetermined	18	9.4	-
Dog Predation	15	7.9	8.7
Other Accidents	5	2.6	2.9
Drowning	3	1.6	1.7
Fire	1	.5	.6

has a shoulder height of 61 to 66 cm, while C. u. philippinus, a possible ancestral race of the Guam deer, has a shoulder height of about 71 cm (Whitehead 1972). Measurements were made of 13 adult buck Guam deer and seven adult does that were taken by hunters. Shoulder height of bucks ranged from 66 to 86 cm, while that of does ranged from 69 to 72 cm (Appendix A). Thus, the Guam deer are within the same size range as the Philippine Sambar (C. u. philippinus).

In terms of body weight, the Guam deer is also relatively light compared to mainland conspecifics. A full-grown Indian Sambar stag weighs about 272 kg, while a stag of the Malayan subspecies weighs about 227 kg (Whitehead 1972). Of 27 bucks reported killed by hunters on Guam during the years 1974 to 1978, the weight reported ranged from 36.4 kg to 136.4 kg with a mean of 58.2 kg. Of 12 does reported killed during the same period, the range of reported weights was 22.7 kg to 56.8 kg with a mean of 38.6 kg. The maximum weight of bucks (with only gunshot wound weight loss) measured and weighed by biologists at special hunts or hunter check stations was 102.3 kg, while that of does was 68.2 kg.

Antlers

Sambar antlers generally consist of a terminal forward-facing fork and a relatively long brow tine branching off the main beam. The Guam deer follows this pattern (Figure 9), however, antlers with four or five tines (on one side) are occasionally reported (Table 10). When there are more than three tines, the additional tines branch off the main beam at the terminal fork. In a study of two captive bucks, it was found that the antler replacement period for an animal going from a spike buck to a two-point buck was 16 weeks. The antler replacement

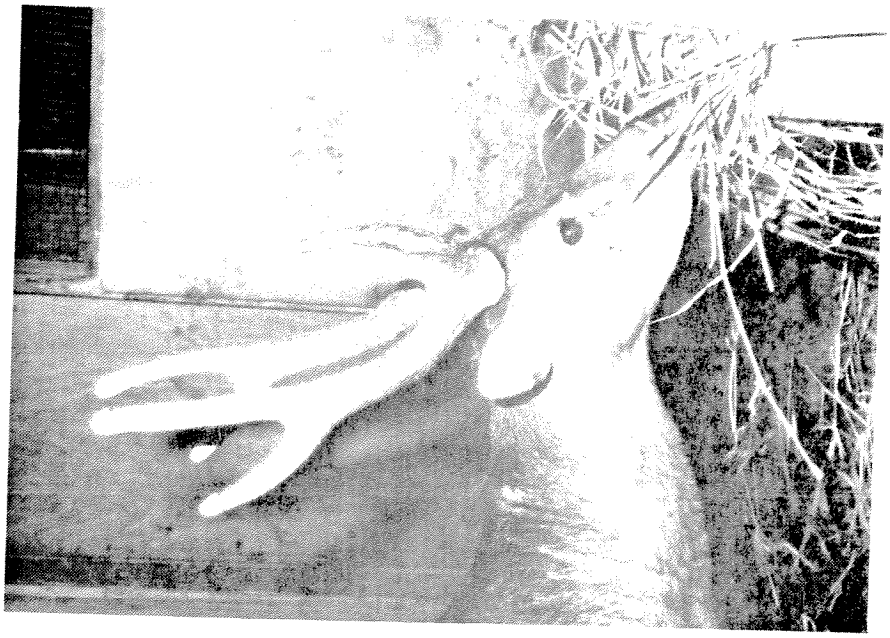

Figure 9. Fully developed three-point buck antlers.

Table 10. Antler Statistics

Antler Development (No. Tines)	No. Reported 1974-1978	Percentage of No. Reported	No. Measured	Total Length Polished (CM)
None	1	4	-	-
Spike	3	12	1	4.5
2	8	32	2	17.5 - 22.0
3	10	40	6	22.0 - 53.0
4	2	8	1	42.0
5	1	4	1	42.5

period of a four year old, three-point buck was 19 weeks. On one occasion a female Guam deer with antler development was noted (AWR 1978), but the occurrence of antlered females is probably rare as only one was noted in 18 years of investigations.

Food Habits

A list of food plant species was developed by examining stomach contents and by field observations of foraging deer (Appendix B). Like other members of the species, the Guam deer is mainly a nocturnal feeder, and it feeds on grasses, wild fruits, shoots, and the leaves of shrubs and trees. Unfortunately, there was no quantitative measure of the importance of each food species in the diet, however, the main food plants noted in stomachs (AWR 1965) were: false elder (Premna intergifolia), wild tamarind (Leucaena glauca), coconut palm (Cocos nucifera), betelnut (Areca cetechu), swordgrass (Miscanthus floridulus), banana (Musa sp.), morning glory (Ipomoea sp.), and grass species such as sanbur (Cenchrus viridis). The Guam deer may be found in areas were there is no free-standing water, such as limestone forest along the northern cliffline.

Aging and Longevity

In 1968 some Guam deer teeth (incisors and molars) were sent to Robert Rausch of the Alaska Department of Fish and Game to determine if cementum rings may be used as a means of aging. This preliminary work revealed that cementum layers were discernable and that the incisors are probably the best to work with. In 1970, 111 deer mandibles were sent to a graduate student, M. Gary Muske, at the University of Minnesota for further work on determining patterns in the deposition of cementum rings. Incisors and molars were sectioned and distinct cementum rings

were noted, however, no correlation was made between ring formation and environmental factors. Further, more detailed work on cementum rings is required to document possible patterns of formation resulting from age, physiology or environment.

A preliminary table for aging Guam deer by tooth eruption and wear was developed in 1966 (Appendix C), based on descriptions of seven known age animals' jaws. The following year age estimates were made of 10 deer jaws returned from the AAFB special hunt in March, 1967. In addition, six known fawn mortalities were used to generate a life table (Appendix D) and a survivorship curve (Figure 10). While one Guam deer lived in captivity for 15 years, it appears from the survivorship curve that most deer in the wild do not live past 8 years.

Diseases and Parasites

While a complete study of the diseases and parasites of the Guam deer has not been done, incidents of fatally diseased deer have been very rare. In 1964, liver flukes were noted in an autopsied deer, but none were found in five deer autopsied the following year. In 1967, three deer that died of disease were tested for rabies and two were found positive. Since that time Guam has become rabies free. Also in 1967, two fawns were tested and found negative for brucellosis and tuberculosis before being shipped to the San Diego Zoo. Of 27 deer examined for ectoparasites, 23 were infested with ticks (*Boophilus* sp.). No other diseases or parasites have been noted.

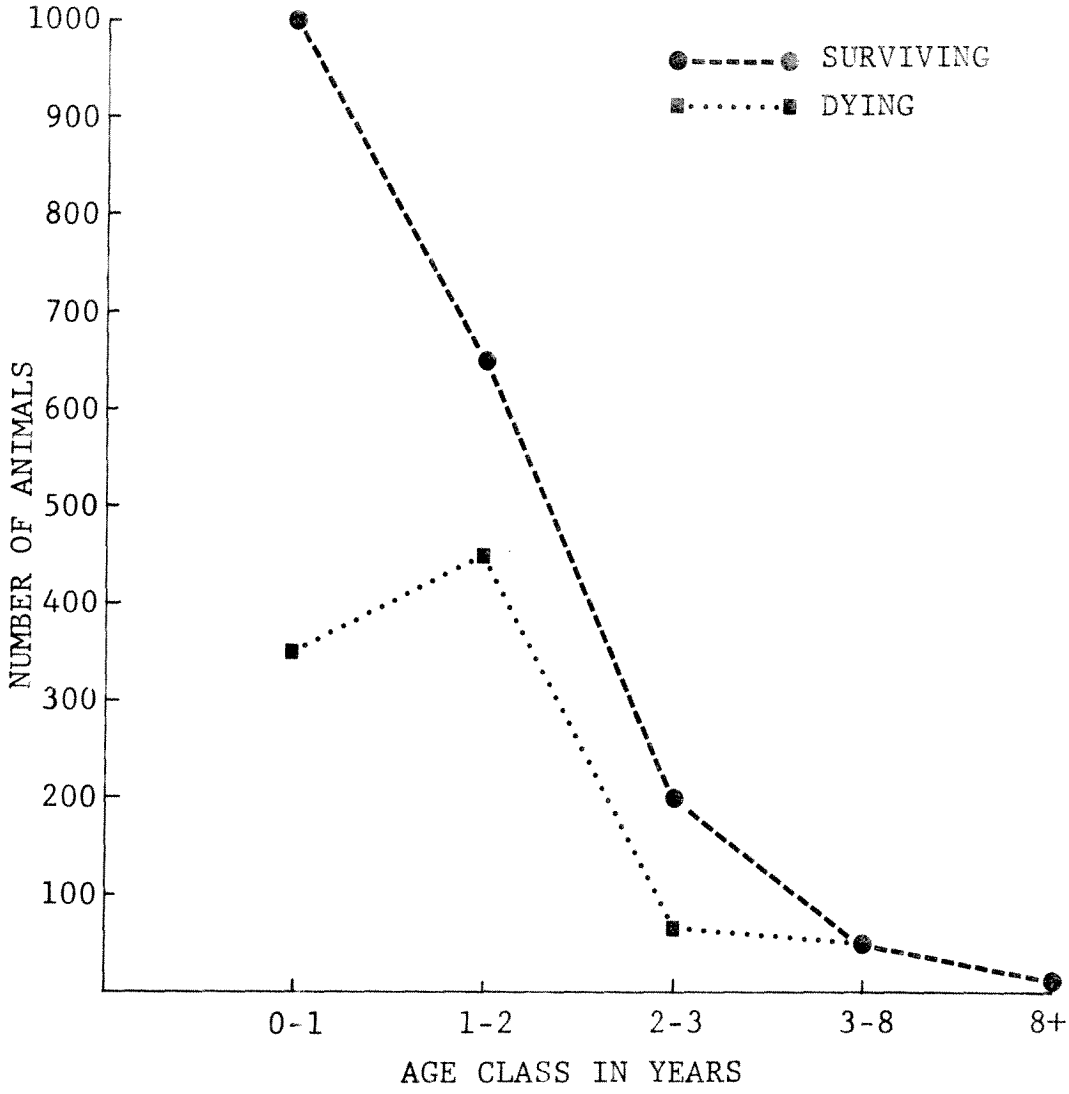

Figure 10. Mortality and survivorship curves of the AAFB deer herd.

MANAGEMENT RECOMMENDATIONS

Problems and Needs

1. There is no island-wide population estimate and deer are easily counted in only a few areas. Consequently, there is a need to develop more sensitive and/or widely applicable census techniques.
2. Mortality due to illegal hunting is not accurately known, but it is probably greater than that due to legal hunting, making it the greatest mortality factor.
3. Nothing is known about movement patterns or home range.
4. Other than a list of known foods, detailed information on food habits is lacking.
5. Problems with illegal hunting exhibit two basic needs: (a) the need for conservation education, and (b) the need for increased law enforcement.
6. Other than social groupings and a nocturnal habit, little is known of the behavior of Guam deer. Such information might be useful towards implementing management goals.
7. Before a comprehensive deer management plan is developed, a quantitative determination of food requirements will have to be made in addition to an estimation of the carrying capacities of areas occupied by deer.

Recommendations

1. Continue the monthly night spotlight counts at AAFB and NavMag. Periodically conduct night spotlight counts in other areas that encompass suitable deer habitat.

2. Statistically analyze the monthly count data to test for significant population changes from previous years. Continued declines may mandate more stringent hunting regulations and/or greater enforcement to curtail illegal hunting.

3. Continue post-mortem examinations of deer, making morphological measurements, attempting to determine the cause of death if it is not hunting, and preserving reproductive and digestive tracts when feasible. Fatally diseased deer should be autopsied by a veterinarian.

4. Place a moratorium on deer hunting on NCS and NWF until deer numbers are replenished in those areas.

5. When deer again become a problem on the flightlines of AAFB, conduct buck only special hunts. Prior and subsequent to each hunt, perform night spotlight counts in the area to be hunted. Use the change in sex ratio from these counts to estimate the population in that area (Kelker 1944, Dasmann 1952). Such a correlation between count data and population size may allow for the estimation of the population in other areas.

6. Initiate a habitat utilization study, using the number of deer pellet groups as an index of use. Such a study would require determining the average number of pellet groups per deer per day for penned deer, and then applying this knowledge to field data on the number of new pellet groups per day in measured plots in suitable deer habitat. In this manner habitat types and/or geographic areas could be evaluated for their relative importance to deer. Combined with recommendation 5, this study could also provide a means of estimating population abundance

in areas where it is difficult to conduct night spotlight counts. It would also be most advantegeous to conduct this study concurrently with a radio-telemetry study of movement to provide a positive check on utilization.

7. An additional biologist should be hired to work extensively on deer. This biologist would work on the following recommendations, with the ultimate goal of drafting a comprehensive, island-wide management plan for deer.

8. A determination of movement patterns and home range is required to evaluate the validity of population estimates for limited geographical areas. Other questions that could be addressed in a movement study include: (a) Do restricted military lands act as refugia from which deer will move out and into less populated, more heavily hunted areas? (b) What is the size of an area over which deer normally range? (c) If problem deer are translocated, how far must they be moved to prevent them from returning to the problem area? To answer these questions a long-term study of tagged deer and a study of radio-collared deer will be required. Deer could be most easily tagged with self-attaching collars placed on trails (Verme 1962), but radio-collaring will require trapping deer or using tranquil darts to capture deer.

9. A study of food habits is required to fill in the gaps of knowledge about the relative importance of forage species and also to determine the food requirements of deer so that an estimation of carrying capacity may be made. Several approaches are recommended. One is field determination of the frequency and intensity of browse signs on preferred browse plants.

Direct observation of the feeding habits of tame or wild deer should also be pursued. The latter will require specialized equipment for night observations (Startron or similar night scope) since Guam deer are primarily nocturnal feeders. Food preference selection by penned deer should also be studied so that the amount of various plant foods consumed can be measured. Finally, the analysis of gut contents initiated in the 1960's should be continued and possibly expanded to include fecal contents analysis. Development of a reference collection and keys to plant parts, plant tissues and seeds would be required, in addition to collecting digestive tracts from hunter killed deer and performing extensive laboratory analyses. Future efforts should be directed towards obtaining quantitative data such as frequency of occurrence.

10. Once quantitative measures of food habits are obtained, vegetative studies should be initiated to determine the availability of food resources in deer habitats and to estimate the carrying capacities of areas occupied by deer.

11. For management purposes it is desirable to produce an estimation of mortality due to illegal hunting so that recommendations may be made regarding enforcement requirements. In the past, mortality due to illegal hunting has likely been the greatest mortality factor. As a consequence, hunting regulations have had little effect in attempts to establish a stable deer population. A study of illegal hunting on Guam should be implemented, utilizing established methods (Beattie et al. 1977) to determine the magnitude of the poaching problem and to estimate the mortality due

to illegal hunting activities. Such a study would be useful in improving enforcement procedures and in setting management priorities.

12. The root causes of illegal hunting are: lack of an appropriate eco-consciousness in local civilians, a low conviction rate, and relatively minor fines for poaching deer. A wildlife conservation education package aimed at local high school and junior high school students would be very helpful in attempting to cultivate an eco-consciousness. In addition, an effort should be made to introduce the legislation required to place greater fines on convicted illegal hunters and to bring about a greater conviction rate through the attorney general's office.

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APPENDIX A. WEIGHTS AND MEASUREMENTS

PART I. GUAM DEER, MALES (1962-1966)

Sex	KILOGRAMS L.W.*	F.D.*	MILLIMETERS T.L	S.H.	H.F.	E.N.	TAIL
Male Ad(V)	-	34.1	1221	667	272	100	90
4 pt.	-	55.5	1420	822	302	100	119
5 pt.	96.4	-	1473	861	343	109	129
4 pt.	90.9	-	1632	842	324	117	114
3 pt.	-	34.1	1213	768	305	100	-
Yr.	-	-	850	609	250	90	94
Ad. (V)	31.4	22.7	1137	660	335	105	105
3 pt.	-	59.0	1346	797	-	104	127
4 pt.	76.4	-	-	833	-	104	133
Yr.	27.3	-	-	-	242	95	104
Yr.	-	-	-	690	330	105	100
5 pt.	75.0	-	1372	775	362	102	122
Ad(V)	38.4	-	1194	654	305	114	102
Ad 3p(V)	84.0	-	1610	920	320	114	145
Ad 3pt.	94.0	71.8	1435	778	343	111	102

*L.W. - Live Weight minus gunshot bleeding.

*F.D. - Field Dressed

(V) - In Velvet

Appendix A. WEIGHTS AND MEASUREMENTS

Part II. GUAM DEER FEMALES (1963 - 1966)

KILOGRAMS		MILLIMETER				
Wt. Live*	F.D.*	T.L.	S.H.	H.F.	E.N.	TAIL
50.0	32.3	1364	759	284	101	140
45.9	29.5	1284	713	257	104	103
33.6	29.5	-	-	-	-	-
53.2	-	1452	761	282	111	121
43.2	30.0	1238	768	270	107	106
39.0	-	1230	688	275	97	106
38.6	-	1302	702	261	97	102
78.8	5.5	1229	654	274	98	135
37.7	-	1200	688	265	96	103
-	23.6	1262	699	287	105	89
-	36.4	1296	726	270	102	100
29.5	-	1247	750	281	-	110
-	-	1207	651	263	98	108
38.6	-	1327	679	314	92	104
21.8	-	889	550	280	92	92
32.7	-	1092	710	279	102	102
-	25.9	1257	698	-	103	146
29.5	26.4	905	683	315	98	103
50.0	-	1346	711	330	104	89

* LW - Live Weight minus gunshot bleeding. Average weight loss 17.9kg.
* FD - Field Dressed

Appendix A. WEIGHTS AND MEASUREMENTS

Part III. GUAM DEER FAWNS (1963 - 1966)

	Kilograms		Millimeters				
Sex	Live * Wt.	Field Dressed	T.L.	S.H.	H.F.	E.N.	Tail
Female	14.1	-	787	457	241	83	83
Male	8.2	-	635	432	228	95	76
Female	14.5	-	-	-	219	89	89
Female	6.8	-	582	325	220	54	60
Male	13.9	-	790	518	-	88	100
Male	20.5	-	945	562	255	94	96
Female	10.0	-	759	488	212	86	91
Male	11.4	-	763	488	227	79	91
Male	3.6	-	549	364	154	62	60
Female	3.2	-	495	341	168	62	59

Live weight minus gunshot bleeding loss.

Appendix A. WEIGHTS AND MEASUREMENTS

Part IV. Some measurements and weights of Guam deer (known age)

Age (Days)	Weight (Kg)	Total Length	Shoulder Height	Hind Foot	Ear	Tail
4-8 days	3.0	527	320.5	77	54	47
4-8 days		520	295.0		51	52
7 days	3.1					
10 days	3.2	600	330	180	55	49
17 days	3.9	620		200	70	49
21 days	3.2					
23 days	3.4	600		172	58	63
28 days	3.6					
29 days	4.8	660	390	213	72	55
35 days	4.3					
40 days	5.7	715	390	220	81	56
42 days	4.8					
49 days	5.0					
53 days	7.0	720		225	81	75
56 days	5.7					
63 days	6.1					
70 days	6.4					
72 days	7.3					
77 days	7.3					
84 days	8.4					
91 days	9.1					
98 days	6.8					
107 days	11.4	769	451.3	205.1	102.6	76.9
132 days	7.7					
120-150 days	7.3					
120-150 days	10.9	885	474.8	264.1	84.6	117.9
152 days	13.2					
195 days	18.2					
210 days	18.2	1051.1	564.1	282.1	102.6	102.6
120-240 days	20.5	1051.1	564.1	282.1	89.7	153.8
300-365 days	29.5					
363-424 days	15.9	1015.4		271.8	89.7	153.8

APPENDIX B. LIST OF KNOWN FOODS OF THE GUAM DEER

PLANT SPECIES		PARTS EATEN		
Scientific Name	Common Name	Seeds	Fruit	Foliage
Angiopteris durvilleana	Fiddle head			X
Areca catechu	Betelnut	X		X
Artocarpus incisus	Breadfruit	X	X	
Bidens pilosa	Stick-tights			X
Bleekeria mariannensis	Yellow-wood	X		
Caesalpinia crista	Fever nut	X		
Carica papaya	Papaya	X	X	
Cenchrus echinatus	Sand burr			X
Cestrum diurnum	Chinese inkberry			X
Citrullus lanatus	Watermelon			X
Citrus species	Oranges, tangerines		X	
Cocos nucifera	Coconut palm	X	X	X
Colubrina asiatica	Gasoso	X		X
Cucurbita peno	Pumpkin	X	X	X
Cycas circinalis	Federiko	X		X
Cynodon dactylon	Bermuda grass			X
Dioscorea species	Yams			X
Discocalys megacarpa	Otot	X		
Disopyros kaki	Persimmon		X	
Elatostema stenophyllum	Topon ayuyu			X
Eragrostis tenella	Love grass			X
Eugenia species	Macupa	X		
Hibiscus tiliaceus	Corkwood			X
Ipomoea species	Morning glory			X
Leucaena luecocephala	Tangan-tangan	X		X
Mangifera indica	Mango		X	
Merrilliodendron megacarpus	Faniok	X		
Mimosa pudica	Sensitive plant	X	X	X
Miscanthus floridulus	Swordgrass			X
Muntinga calabura	Panama cherry			X
Musa species	Banana			X
Oryza sativa	Rice			X
Pandanus dubius	Screw pine			X
Panicum purpurascens	Para grass			X
Passiflora foetida	Passion vine	X		X
Pasparlum orbiculare	Rice grass			X
Pennisetum purpureum	Hapier grass			X
Phaseolus species	Common bean	X		X
Piper betle	Betle pepper			X
Premna interifolia	False elder	X		X

APPENDIX B. LIST OF KNOWN FOODS OF THE GUAM DEER (cont.)

PLANT SPECIES		PARTS EATEN		
Scientific Name	Common Name	Seeds	Fruit	Foliage
Rhynchelytrum repens	Natal redtop grass			X
Saccharum officinarum	Sugar cane			X
Scaevola taccata	Sea lettuce shrub	X		
Setaria pallide-fusca	Golden foxtail			X
Sorghum halepense	Johnson grass			X
Terminalia catappa	Talisai	X		
Ximenia americana	False sandalwood	X		
Zea Mays	Corn			X

APPENDIX C

GUAM DEER AGING BY TOOTH WEAR AND ERUPTION

Division of Fish and Wildlife, September, 1966
(A Preliminary Criteria by: Jerry Perez)

AGE	TEETH PRESENT			LENGTH (MILLIMETERS)			CHARACTERISTICS
	Incisors	Premolars	Molors	Lower Jaw	Tooth Row	Diastema	
6-8 Weeks (1 female)	1-2-3-4	2-3-4	0	96.0	37.0	19.0	All PM half erupted; dentine completely covered by enamel and occlusal surface sharp in all PM.
3 to 4 months (1 male and 1 unknown)	1-2-3-4	2-3-4	1 (trace)	110.6	37.0	32.0	Dentine discontinuously exposed on anterior buccal side of both 3rd and 4th PM; 3rd PM not as sharp as 4th PM; 1st M beginning to erupt.
12 months (1 female)	1-2-3-4	2-3-4	1	155.0	52.0	44.0	Dentine slightly exposed in 2nd PM; and 3rd and 4th PM generally exposed continuously; 1st M 3/4 erupted; 4th PM and 1st M sharper than 3rd PM.
18 months (2 males)	1-2-3-4	2-3-4	1-2(trace)	165.0	54.0	46.0	As in 12 months, but 2nd beginning to erupt. Also, dentine beginning to show on anterior 3/4 of lingual and buccal sides of both left and right 1st M.

AGE	TEETH PRESENT			LENGTH (MILLIMETERS)			CHARACTERISTICS
	Incisors	Premolars	Molars	Lower Jaw	Tooth Row	Diastema	
3 years (1 male)	1-2-3-4	2-3-4	1-2-3	198.0	90.0	50.0	Occlusal surface of 2nd PM sharp and dentine not exposed continuously in either left or right tooth; 3rd PM as in 2nd PM, but not as sharp. Both left and right 4th PM 3/4 to complete circle of enamel on anterior occlusal surface. Posterior edge of 3rd M completely covered with enamel on both left and right teeth. Crest of buccal side of posterior cone of 3rd M higher than crest of lingual side in both left and right tooth.
4 years (1 male)	1-2-3-4	2-3-4	1-2-3	205.0	88.0	45.0	Infundibulum of anterior cone of 4th PM not completely surrounded by dentine (interrupted by enamel) in both left and right tooth. First and 2nd M as in 4th PM. Infundibulum of posterior cone of 3rd M not completely surrounded by dentine (interrupted by enamel) on both left and right tooth.

APPENDIX D

Life Table of Andersen Air Force Base Deer Herd.*

x	d'x	dx	lx	qx	lx
0-1	6	370	1000	370	717.0
1-2	7	434	630	689	377.5
2-3	2	125	196	638	129.5
3-8	1	63	63	1000	31.5

* x = Age class in years

d'x = Number dead in age class x

dx = Number of deaths per thousand

lx = Number of survivors per thousand

qx = Death rate per thousand

lx = Survival rate per thousand