A Preliminary Study of the Deer from Cedros Island, Baja California, Mexico

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To my parents

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INTRODUCTION

OVERVIEW

The International Union for Conservation of Nature and Natural Resources (IUCN) initiated a programme for the study and management of Cervidae threatened with extinction throughout their world ranges. The objectives are to improve the status of the deer by more effective management, and to stimulate and provide experience in sustained scientific and governmental involvement with threatened taxa.

Cowan and Holloway (1973), considered the Cedros Island Deer, Odocoileus hemionus cerrosensis Merriam 1898, from the island lying off the western coast of the Baja California Peninsula, Mexico, as one of three deer of unclear status considered as candidates for inclusion in the Red Data Book. They include: (1) the nominate race of the Musk Deer, Moschus moschiferus moschiferus (Linnaeus 1758), from northern India and the Himalayas, (2) the Calamian Deer, Axis calamianensis (Heude 1888), from the Calamian Island group, in the Phillipines, and (3) the Cedros Island Deer.

A few years later, the Cedros Island Deer was listed as endangered in the IUCN Red Data Book and still badly in need of a study to determine its actual status. Undertaking such a study was encouraged based on urgency and its probable

feasibility (Holloway 1978). In fact, the only information available on the status of this animal was anecdotal and unverified. For practical purposes, virtually nothing was known about the current state of the population. Given this unsatisfactory state of knowledge, planning of a study was begun by Dr.Dale McCullough at the meeting of the Threatened Deer Committee held in Longview, Washington U.S.A. on September 26-October 1, 1977.

My opportunity to participate in the study and conservation of the Cedros Island Deer is attributable to the praiseworthy concern of the IUCN and its sister organization, the World Wildlife Fund (WWF) in the initiation , promotion and coordination of action to ensure the survival of the living natural resources . Secondly , it is also derived from Dr. McCullough's invitation to get involved in the study.

The IUCN, made funds available for a preliminary visit to Cedros Island, Mexico, to evaluate the feasibility of a study of the Cedros Island deer, under the condition that the visit should be coordinated with the Mexican Wildlife Service (Direccion General de Fauna Silvestre, Subsecretaria Forestal y de la Fauna, SARH), for their involvement in the project from the beginning was essential.

The preliminary visit to Isla Cedros took place in late January 1980. The outcome of the visit was that we were convinced an initial study was both feasible and desirable.

OBJECTIVES

For over a 4 month period (June to October 1980) a study was conducted to determine the population status and to gather basic information on the life history and ecology of the Cedros Island Deer. The specific objectives of this study included the following :

(1) Verify the present occurrence of the deer on the island.

(2) Collect data on the physical characteristics of this endemic subspecies.

(3) Determine the distribution of the deer over the island.

(4) Determine the relative abundance of deer over their range.

(5) Characterize the important habitat requirements, particularly with regard to food resources, water availability, resting and escape cover, etc.

(6) Evaluate the decimating factors on the population, and

(7) Evaluate the prognosis for survival of the deer on the island.

An understanding of the habitat requirements of this deer and factors responsible for its decline are necessary to determine the actual population status and form the basis of a conservation plan to be recommended to the Mexican Wildlife Service, the WWF and the IUCN.

STATUS OF THE DEER

In the late 1920's deer were fairly abundant on the island, due in part to the 1923-1928 Mexican moratorium on killing deer. Deer still occurred on the island in the 1930's(Cowan 1936). Within those two decades most of the specimens and other material in scientific collections were obtained (1922, 1932, 1933, 1936, 1938; A.W. Anthony and others).

A large gap separates the first accounts (most comprehensive and updated of which was Cowan's 1936 publication) and the relatively recent reports on the deer of Cedros. What happened to the population between those years was not recorded.

In 1948 no deer were seen on the north end of Isla Cedros, the rumored area of concentration of deer on the island (Osorio-Tafall 1948). Animals were said to be heavily hunted by fishermen at all times of year (Taylor 1956).

By 1964 the way in which people referred to Isla Cedros deer had changed dramatically. Huey (1964) warned that due to overhunting by residents of the island , this subspecies was fast approaching extinction.

In the 1970's in over a 8 year period, while studying and collecting plants of Cedros, M.Benedict saw just 3 individuals (pers.comm.). On the prospect of conducting a preliminary study on the deer (1977), Thomas Kucera made two trips to the island. He first found just signs of deer, but on the second trip, observed an adult female near the north end of the Island (Kucera pers.comm.).

Cowan and Holloway (1978) summarized the few things known about this subspecies. About 50 animals were thought to remain on Isla Cedros, confined to an area of pine forest and chaparral in the southern sector of the island. Poaching and feral dogs were considered major threats to the population (Cowan and Holloway 1978). There was concern that the subspecies was not just endangered but perhaps already extinct. However, in a short, recent field trip to the island, the Mexican Wildlife Service came up with an estimate of 150+/-35 animals. A year before their estimate was 69 individuals (Salas 1979; C.Vera pers.comm.). This estimate was based on the observation of deer tracks and therefore not much faith can be placed in the absolute value. The amount of time and effort given to such estimates made them a poor basis for concluding anything except that the population was not extinct.

The knowledge of at least the presence of deer on Isla Cedros is surprisingly not widespread among the local residents. And even more surprising is the fact that the descriptions of what the animals are like, given by the few who claim to know something about them, show strong discrepancies. To illustrate how little is known locally about this animal some of the multiple versions heard are worth translating.

> ...the ungulates on the island are no deer, they are "cornicabras", which are smaller and quite different from deer ["cornicabra" is a word derived from cuerno=horn (antler in this context) and cabra=goat]...
>
> ...deer are like miniature reddish gazelles, the size of a medium-sized dog... ...males grow a pair of "horns" resembling spikes that are not shed year after year, but on the contrary grow larger slightly projecting backwards... ...even large bucks are never bigger than a medium-sized dog...
>
> ...animals here are the size of a regular white-tailed deer elsewhere...

Still greater discrepancies in opinion exist concerning the animal's behavior. Depending on the source, deer were said to be evasive, scary, timid, bold, curious, shrewd or cunning.

DESCRIPTION OF THE ISLAND

NAMES

At the time of its discovery (1540) the Island was named "Isla de Cedros" or Cedar Island by Spanish Captain Ulloa. Ulloa named the island after "some pines and cedars" he had observed on high hills. The so-called "cedars"(Cedros in Spanish), were actually junipers (Barco 1973). Captain Vizcaino, on the other hand named it "Isla de Cerros" or the Peak or Mountain Island (1602). The latter is perhaps more appropiate considering that it describes the rough nature of the island.

Father S.Taraval registered in his manuscripts the name the Indians gave to the island, "Huamalgua" or "Guamalgua", that means "the foggy" (Eyer Wilbur 1967). The aboriginal inhabitants of the island had given their land the most appropiate name inasmuch as more than half of the island is always covered by a cloud-fog mantle. Paradoxically the least appropiate name given to the island, "Isla Cedros", is the one in use.

LOCATION

Isla Cedros is a continental island located in the Pacific Ocean, 65 km off the west coast mid-way down the

Baja California Peninsula, Mexico, situated between the parallels 28°02'20'' and 28°22'55'' north latitude and the meridians 115°21'30'' and 115°09'20'' west of Greenwich longitude (Osorio-Tafall 1948).

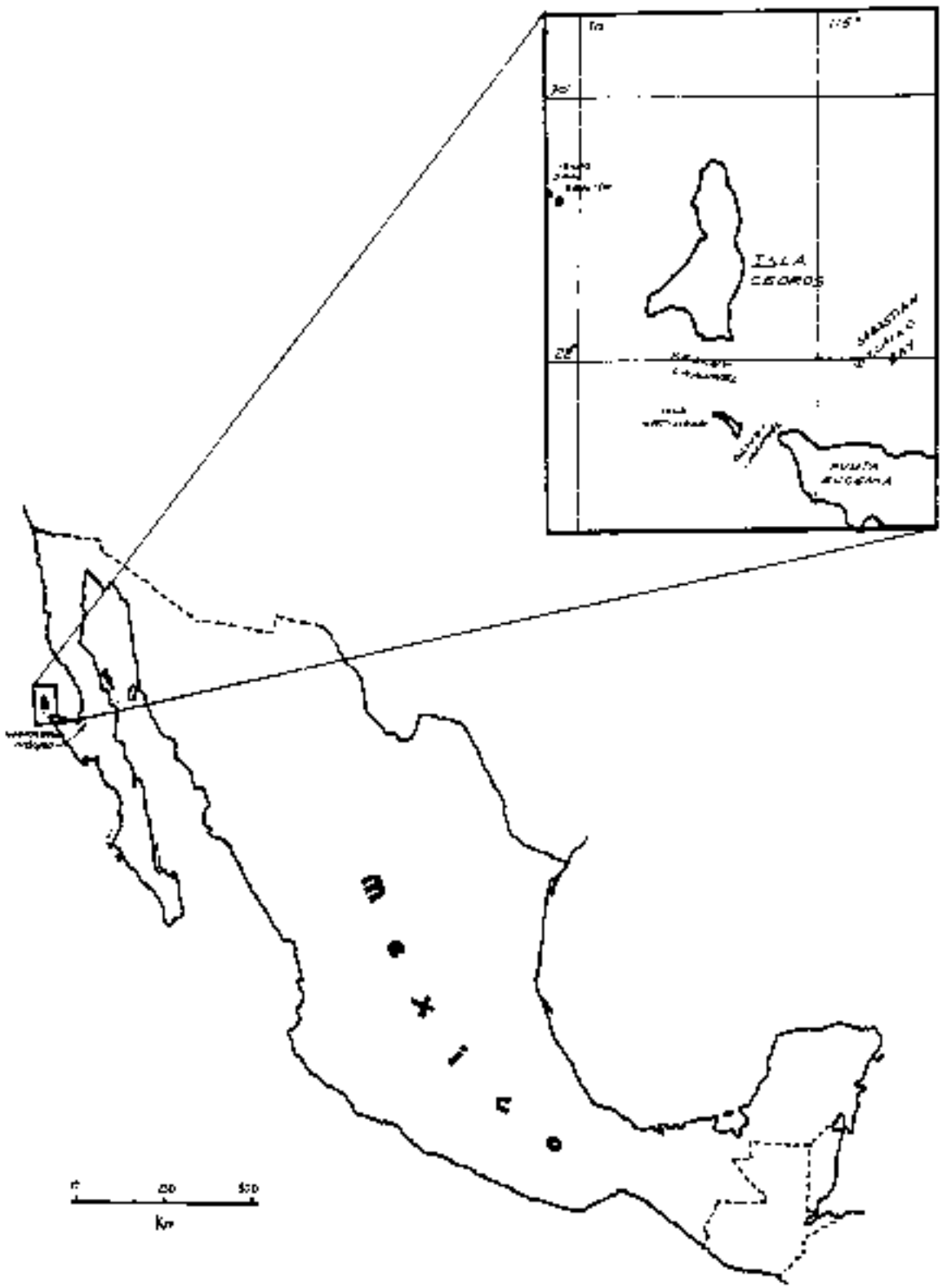
Cedros is accessible only by plane, for no passenger boats get to the island. It is about 121 km by air from the nearest larger town, Guerrero Negro, and just 24 km from Punta Eugenia, the nearest but desolate point on the mainland (Fig. 1).

TOPOGRAPHY AND SIZE

Cedros Island is about 360 km^2 in extent and rises quite steeply from the sea to a backbone of mountains . The island is triangular in shape, with one of its vertexes near the lighthouse in the northern tip (by Campo Punta Norte). The other two vertexes correspond with Cabo San Agustin on the west and Punta Morro Redondo on the east. It is 38 km long in a general north-south direction. Its east-west width varies from 18 km at the widest extreme to 6 km in the narrowest portion, some 16 km south of the northern tip.

As a continental island, Cedros is connected with the Baja California Peninsula. An estimated drop of around 55 m in the sea level would show Cedros and Punta Eugenia to be part of a once continuous mountain range (Bostic 1975). A similar drop of twice as much would expose the link between

Figure 1 Location of Isla Cedros, Baja California, MEXICO


ISLA
CEDROS
M e x i c o
0
200
400
Km

Cedros and San Benito Islands. Therefore, Natividad, San Benito and Cedros are considered a northwestward prolongation of the Sierra del Vizcaino (on the mainland). Diverse mineral strata tilted in different directions are geological testimonies of tectonic movements that affected the island in the Pleistocene. Thus, the isolation may have been a result of a recent submergence phenomenon. Cedros was connected to the peninsula and presumably, at some time within the last 2 million years, became isolated by a sea water gap across the Kellet and Dewey channels (Osorio-Tafall 1948).

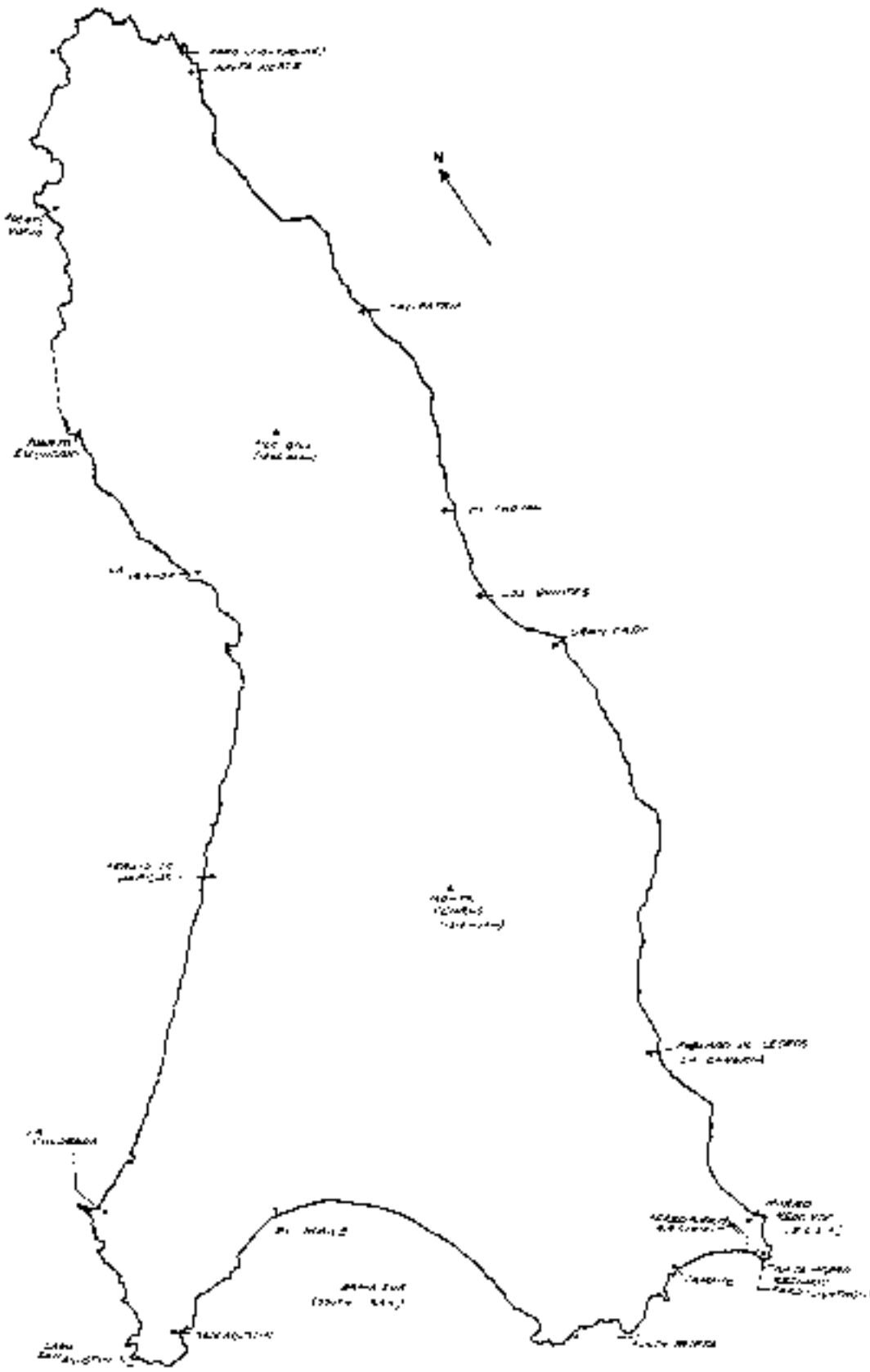
Isla de Cedros has a characteristic peculiar faulty terrain, it is highly eroded, and its rocks seem to be loosely placed in position. The mountain range of which most of the island is composed, is formed by lofty peaks, steep slopes and rugged cliffs, all highly eroded. The western slope of the mountains is generally very steep, and drops precipitously to rugged cliffs at the sea. The eastern slopes are somewhat less steep and the shore, being on the leeward side, has many coarse stony beaches. The northerly mountain range extends from the northern tip southward about 16 km, eventually terminating between the drainages called El Choyal and Los Quiotes. Several eroded summits project distinctively from the craggy backbone of this alignment.

South of the northern tip, elevation rises first from 600 m (above the sea level) to 700 m first and to 900 m, some 4 km from the tip. The highest peak in this range is Pico Gill with an elevation of 1200 m. To the south of this peak, the ridge's summits are 600 m high on average; in the narrowest portion, however, the summit has an elevation of 1000 m.

As the island widens further south, a second mountain chain emerges, running from north to south. The first summit on the north has an elevation of 600 m deliniting the entrance to the Gran Cano drainage to the west. South of the Gran Cano the elevation ascending gradually to a large mountain mass, of which Monte Cedros, with an elevation of over 1300 m, is the highest peak.

A third chain of mountains begins at Cabo San Agustin in the extreme southwest, skirts Bahia Sur, and merges with the mountain mass which lies south of the Gran Cano. Sierra del Morro forms the east side of Bahia Sur in the southeastern part of the island. This sierra runs from Punta Prieta northwards, with average maximum elevations of 450 m. It delimits the levelest southeast portion of the island, location of the island's villages, cannery, salt loading port, cannery pier and airfield (Fig.2).

Figure 2. Human Settlements and Toponymy.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CLIMATE

Since no meteorological data are available for the island, descriptions of climate are based on the few data reported in the literature (Osorio-Tafall 1948), information given by local residents, data recorded in our studies, and data provided by Exportadora de Sal S.A.(ESSA) for the overall region (Table 1). Credit should be given as well to data provided by the Governmental Climatological Stations No.2 and No.31 located in Bahia de los Angeles, and Rosarito, Baja California, respectively.

The main rainy season extends from late November to mid-February, to a certain extent corresponding to the winter regime of the west coast of the United States. However, rainfall is common in September. Thus a secondary rainy season has been proposed for late summer, corresponding to the regular tropical summer regime seen elsewhere in the west coast of Mexico (Madrigal-Sanchez 1970). Yearly average rainfall is about 200 mm for most of the island and perhaps is a little greater at higher elevations. However, years without effective rainfall are known to have occurred.

Annual mean temperature is around 16.8° C with September and October the warmest months (mean around 21.4° C) and December to February the coolest (mean temperature 13.7° C)(Osorio-Tafall 1948).

Table 1. Average fresh water evaporation and rainfall by month for the Vizcaino Bay Region in a 20 year period (1960-1979).[+]

Month	Evaporation (mm)			Precipitation (mm)		
	min	max	avge	min	max	avge
January	55	116	84.22+/-18.51	0.0	52.12	15.16+/-14.31
February	53	136	95.70+/-20.04	0.0	73.66	12.94+/-16.87
March	120	180	144.00+/-13.96	0.0	13.21	6.05+/-4.47
April	149	221	170.22+/-16.78	0.0	4.83	1.27+/-1.63
May	132	211	181.17+/-21.45	0.0	17.78	2.71+/-5.83
June	150	217	177.91+/-16.78	0.0	7.62	0.80+/-2.40
July	166	211	190.35+/-15.10	0.0	17.58	2.93+/-5.88
August	173	251	194.22+/-22.52	0.0	8.64	2.49+/-3.08
September	119	193	165.17+/-16.21	0.0	56.64	15.08+/-18.41
October	108	174	145.70+/-16.47	0.0	41.40	14.07+/-21.13
November	52	133	102.75+/-15.74	0.0	39.12	8.20+/-12.02
December	56	150	81.54+/-20.56	0.0	109.73	18.94+/-19.82

[+]Modified from raw data provided by E.S.S.A.,Guerrero Negro MEXICO.

Maximum temperature has not exceeded 38.0° C, in the past 21 years, whereas the minimum has never dropped below 0.0° C during the same period. High temperatures are counteracted by constant fog and wind, and low temperatures are mitigated by the surrounding Pacific ocean waters.

Average wind velocity for a 10 year period was 20.46+/-3.64 km per hour. The whole island serves as an enormous wind-shield for the adjacent mainland and at the same time as a funnel that directs the dominant currents down south Baja California. Winds are usually strong, especially during spring and summer. Effects of wind can be seen easily at higher elevations, where uprooted pine trees and fallen branches are common. Wind storms are expected by the local fishermen in late February and early October (Garcia G.pers.comm.).

The characteristic fog-cloud mantle that covers the west side of the island, is present all year, and is thickest during the summer months.

Relative humidity oscillates around 69% throughout the year in the whole Vizcaino Bay Area as recorded by E.S.S.A.. In Isla Cedros, however, humidity varies considerably depending upon where the readings are taken. East exposure slopes are drier than the west-oriented ones and slopes and ridges are drier than drainage bottoms. As would be expected in this type of environment, the flatlands are the driest. In contrast, in the fog-clouds areas under the canopy of the few forested summits, relative humidity

values of 100% were often recorded. Thus, actual relative humidity values exclusive for the island may differ from the ones summarized in Table No.2 .

VEGETATION

Several collections of plants have been made on Isla Cedros (Eastwood 1929, Hale 1941, Benedict and Moran 1971-1980). The known Flora of Cedros includes 231 vascular plants; according to Moran (1972), about 208 of these appear to be native and 23 to be introduced. Further exploration probably will add at least a few other native plants. New weeds doubtless will continue to arrive.

Sixteen plants are still known only from Isla Cedros, and thus are tentatively considered endemic. Eleven more, first described from Cedros, appear to be narrowly endemic but are known from one or more other places, either on nearby islands or in the adjacent areas on the peninsula. Few have a very restricted distribution on the island, some others may later be found elsewhere but several of them, such as the pine, may definitively be endemic.

Cedros Island belongs to the Vizcaino Desert Phytogeographic area (Coyle and Roberts 1975). According to Hale (1941), the diverse flora of Cedros is composed of six major plant associations, all represented and to some

Table 2. Average Wind Velocity, Temperature and Relative Humidity by months for the Vizcaino Bay Region.+

Month	Wind Velocity (km/hr)				Temperature (°C)				Relative Humidity (%)			
	max	min	avge	+/-	max	min	avge	+/-	max	min	avge	+/-
January	33.25	2.77	14.73	2.34	22	6	14.05	1.81	89	22	63.09	6.12
February	38.57	4.59	18.30	1.50	22	7	15.73	2.62	95	31	64.18	8.64
March	42.28	7.85	22.06	2.52	23	8	15.86	1.95	94	38	66.18	8.20
April	45.72	10.78	25.69	1.43	25	11	17.05	1.37	94	48	70.55	6.89
May	42.03	9.93	24.07	2.12	24	8	17.91	1.64	98	51	72.40	5.83
June	42.70	7.74	22.49	1.82	26	14	19.32	2.24	95	51	73.60	6.26
July	37.05	8.67	21.87	1.57	30	13	21.09	2.01	88	48	69.91	5.17
August	39.00	7.56	22.57	2.47	32	17	22.59	1.89	86	52	69.91	4.50
September	40.20	4.63	21.41	2.60	30	16	22.27	1.44	88	54	70.36	4.23
October	34.40	3.64	19.01	2.66	29	11	20.05	2.76	92	47	69.36	5.73
November	32.04	3.60	16.53	2.63	26	8	17.82	2.93	94	34	69.36	4.63
December	37.87	2.46	14.43	2.67	22	5	14.77	2.67	95	22	66.09	8.29

+modified from raw data provided by S.S.A., Guerrero Negro, MEXICO (1969-1970).

extent better developed in northwestern Baja California and in Alta California. The six associations can be grouped into three major vegetation types: (1) Pine Forest, (2) Juniper Woodland and (3) Chaparral and scrubs. The latter includes the not always distinct coastal sage scrub, maritime dune scrub and desert scrub.

The closed-cone pine forest near the middle and north end of the island is unquestionably the most noteworthy departure from the dominant desert vegetation. The pines occur in three well separated groves, with outliers, covering an estimated total of 170 hectares (1.7 km^2), less than 1.0% of the island's total area (Moran 1972). The groves are spread along the divide north of Pico Gill, about 6.5 km north of Monte Cedros and at the summit by El Choyal in the narrowest part of the island (Fig.3).

They are confined to the high western and northern slopes and cliffs, mostly at 400 to 600 m elevation and rarely below 300 m. The pines grow in quite pure stands, sharply set off from the desert vegetation. Cover and height vary from 40 to 60 % and from 10 to 22 m, on average, respectively. A sparse undergrowth of shrubs and herbs may eventually be present, cover for the latter has been reported to be at the most 15 % whereas herbs cover less than 5 % (Madrigal-Sanchez 1970).

These pine stands are not well known. Although they have been transplanted to different places as far as

Australia for morphological, genetical and taxonomical studies, their taxonomy is, paradoxically, still uncertain. Rzedowski (1978) mentions the possible occurrance of Pinus remorata, P. muricata, and P. radiata as 3 distinctive species on Cedros. However, the pines of the island have specifically been referred to Bishop pine as Pinus muricata var.cedrosensis Howell. And lately, various authors agreed that as their morphological characters suggest, the pines of Cedros are taxonomically very close to the Monterey pine Pinus radiata var.binata Don. The resemblance includes the schedule of flowering (phenology), morphology of flowers, conelets and cones (Fielding 1961, Madrigal-Sanchez 1970 and Moran 1972).

The juniper woodland is dominated by the California Juniper, Huata or Enebro, Juniperus californica Carr., often, and mistakenly, called Cedro. Junipers are more abundant on higher peaks and ridges between 1000 and 1200 m elevation, but also extend well down in some canyons. In particular, some slopes on Monte Cedros with southwest aspect are covered with scattered, almost pure juniper groves .

A non-typical southern California Chaparral occurs on the north slopes of Monte Cedros and Pico Gill and in small patches on other peaks and ridges. Hale (1941) estimated that chaparral covers a total area of less than 1.0 % of the area of the island. It is a patchy association of encina,

the cedros oak (Quercus cedrosensis Muller), chamise (Adenostoma fasciculatum Wats.) and manzanita (Xylococcus bicolor Nutt.). It is poorly developed and often intergrades with desert vegetation. Other components are the genera Heteromeles, Caenothus, Rhamnus, Garrya and Diplacus.

One small area of poorly developed coastal sage scrub occurs on the north slope of Monte Cedros, just below the 900 m elevation. Flat-topped buckwheat (Eriogonum fasciculatum Nutt.) and the coastal sagebrush (Artemisia californica Less) are the dominant components. Other genera present are Lotus, Eriophyllum and Gutierrezia. Buckwheat is common throughout the island and the other genera also occur elsewhere on Cedros; but not in this association that Hale treated separatedly (Hale 1941 and Moran 1972) (Fig. 3).

The maritime dune association consisting predominantly of saltbush (Atriplex julacea Wats.) and frankenia (Frankenia palmeri Wats.), is found along the sand dunes of the southwest coast to the north of Morro Redondo. Other dune plants, not found elsewhere on the island, include Abronia, Achyronychia and Camissonia.

The most diagnostic plant community of the island is the desert scrub. According to Hale (1941), 97 % of the island from shore to the highest peaks is covered by this association. Desert scrub is open, with widely spaced

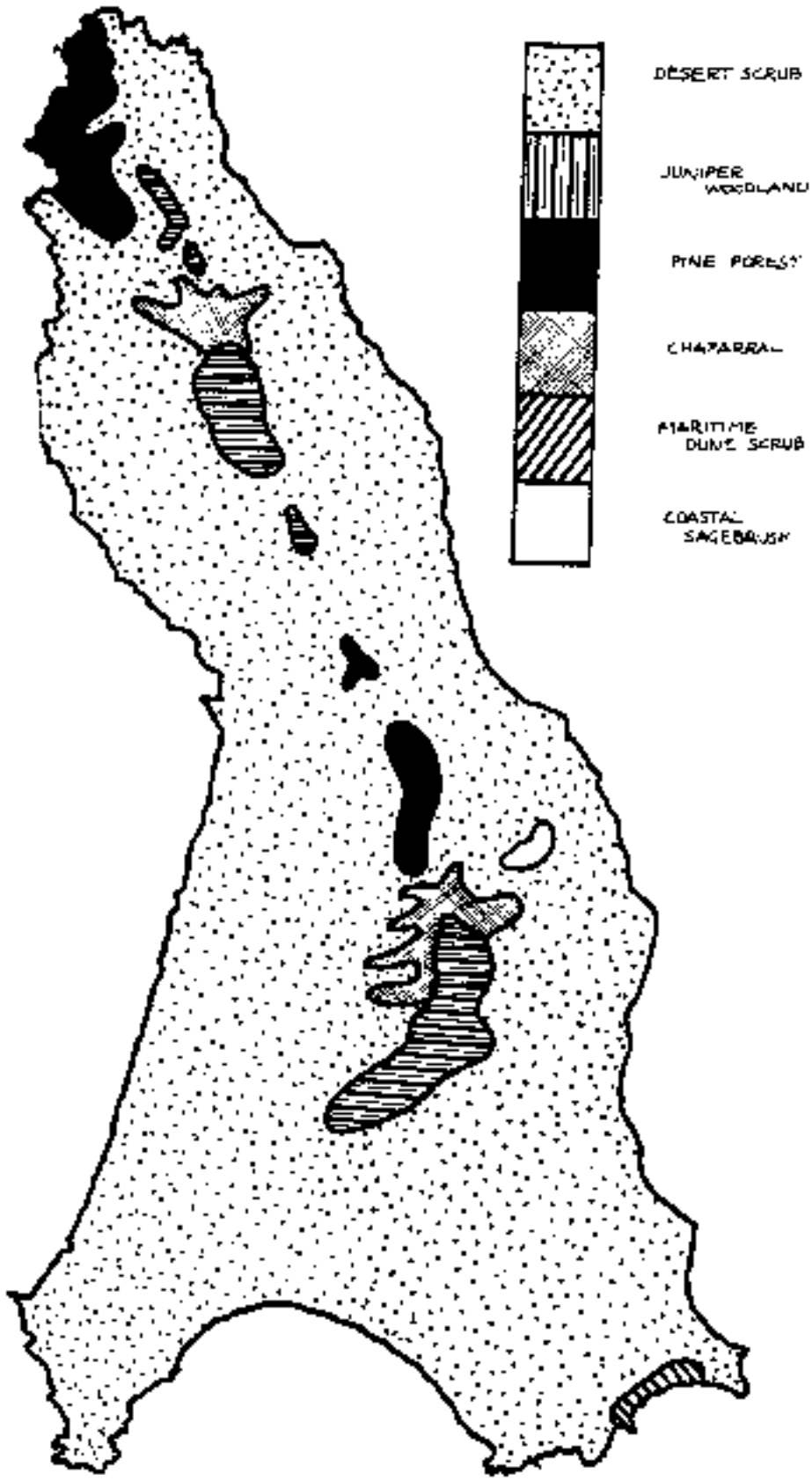
perennials, and the dominant plants are diverse in size and represent many and diverse life forms (Moran 1972 , Shreve and Wiggins 1964). The most striking and conspicuous plants over most of the island are copalquin, or elephant tree (Pachycormus discolor Cov.) and maguey or century plant (Agave shawii var.sebastiana Gentry). Copalquin on Isla Cedros often grow postrate on the ground in response to the persistent winds. Smaller cacti are common, including the viznaga and the viznaguita (Genera Ferocactus and Cochemiea respectively). Less common cacti are the large cardon (Pachycereus), the garambullo(Lophocereus) and the pitahaya agria(Machaerocereus).

At middle and high elevations, especially on north slopes, the desert scrub in some areas gives place to the other types of associations mentioned before.

TERRESTRIAL MAMMALS

Little is known about the terrestrial mammals that inhabit Isla Cedros. No systematic collections nor extensive study visits have been conducted. It would not be surprising in future surveys to find at least few more

Figure 3 Vegetation of Isla Cedros


DESERT SCRUB
JUNIPER WOODLAND
PINE FOREST
CHAPARRAL
MARITIME DUNE SCRUB
COASTAL SAGEBRUSH

endemic mammals at the subspecies level.

At present, two species are considered endemic, the Cedros Island pocket mouse (Perognathus anthonyi) and the wood rat (Neotoma bryanti). Three endemic subspecies have been proposed in the scarce literature: the Cedros Island brush rabbit (Sylvilagus bachmani cerrosensis), white-footed mouse (Peromyscus eremicus cedrosensis) and mule deer (Odocoileus hemionus cerrosensis).

The sea-otter (Enhydra lutris nereis) formerly present in Isla Cedros is now extinct in all of Baja California.

Besides the aforementioned species, six other mammals have been introduced to the island at different times and are still present; rats and house mice and feral cats, dogs, asses and goats.

HUMAN SETTLEMENTS AND ACTIVITIES

Cedros Island has a population of about five to six thousand human inhabitants. A large percentage of them come from the mainland. There are two villages on Isla Cedros. Both, together with the airstrip are located on the levelest terrain on the southeastern tip of the island.

El Morro or La Exportadora , located at the very south-east tip, amid the landing strip and the salt loading wharf, houses most of the employees of ESSA. Whereas "El Pueblo", "La Caneria", "Cedros" or "La Planta", located about 5 km

straight north from the tip, is the larger settlement. The only road, a winding, unpaved, four-lane, 8 km long road connects both human settlements .

The only other occupied parts of the island are several lobster and abalone fishermen camps scattered along the coast-line. These camps or "Campos" are inhabited by up to 14 fishermen for six months in a year. They stay while the fishing season lasts and take turns returning to the village every once in a while.

Campos El Huaile, San Agustin, La Colorada, Puerto Escondido and Punta Norte are regularly occupied in season. Off-season, the former, together with Calipatria and Campito, are transient shelters for the fishermen (Fig.2).

Traditional sources of livelihood for local residents can be summarized in the following activities: (1)lobster trapping, (2)diving abalone, (3)fishing with small net or seine and/or hook and line, (4)fishing in purse seiner equipped boats and, (5)working in the cannery. Setting the lobster traps, tending the submerged abalone divers, hook and line fishing or off-season seining are done from small outboard motored skiffs. Besides them, a small fleet of purse seiners from Cedros fishes the Vizcaino Bay, considered one of the most important spawning areas of the Pacific Coast year round.

The cannery, run by "Productos Pesqueros Isla de Cedros" (PPIC, a division of the government-affiliated "Productos Pesqueros Mexicanos"), centralizes the production

of seafoods on the island. Fishermen are organized into a Cooperative Fishery or "Cooperativa" (Sociedad Cooperativa Pescadores Nacionales de Abulon, P.N.A.) run by them. The Cooperativa buys the products (fish, abalone and lobster) from its member fishermen and either sells them to the cannery or sends them directly to the market in Ensenada.

The cannery produces fish-flour out of fresh waste materials and low priced fish (parenthetically, odourizing the village almost on a daily basis). Pack of Tuna is a thriving operation that left behind abalone, sardines and mackarel as the leading canned products. Crab, sea urchin, some fish species and other potential commercially-profitable marine resources are being investigated.

Recently, two other activities were added to the previously mentioned sources of livelihood. First, the collection of a sea-bottom growing species of seaweed (division Rhodophyta). A source rich in Alginates erroneously called "Sargazo" locally (kelp in English). And secondly, since 1967, working for ESSA at El Morro.

Salt is obtained from large evaporation ponds and crystallization areas by Guerrero Negro. Once it has been "harvested" and washed on the mainland, highest quality salt (99.72 % NaCl) is transported daily to the island.

Transportation is done on laden 6500 ton capacity (metric ton) barges hauled by Tugboats. On Cedros, endless belts drop salt onto supertankers (Deep-draft

vessels up to 156,000 ton load capacity), for export mainly to Japan and the U.S.A..

Without exception, all residents are, in one way or another, linked to the PPIC Cannery and/or to ESSA. These companies cover independently most of their employees' needs.

The population is undergoing an economic boom. The cost of living is very high by Mexican standards. Besides the strong economy resulting in a considerable cash flow that tends to drive up prices, no foods other than seafoods are produced on the island. There is no farming . Thus, most of the food and supplies are flown in from Guerrero Negro or Ensenada, on "regular" cargo planes.

Despite the ever increasing facilities and commodities availability, newcomers and temporal workers do not stay for long on the island. The great majority leaves right after or even before termination of a job-contract. Perhaps owing to the conditions under which jobs are offered and taken, or due to the nature of the jobs themselves, there is a remarkable higher proportion of men in the population.

METHODS

MAP CONSTRUCTION

No reliable maps of the entire island were available at the beginning of the study. However, recent aerial photographs were available except for a small portion of the island, on the west coast.

Rectified-scale photographic mosaics of the island were made after the original aerial pictures (provided by Direccion de Estudios del Territorio Nacional, DETENAL, Mexico). Maps showing the outline of the island were made after the 1:100,000 mosaic. The outline was reproduced in paper for future use in the field.

In order to develop a coordinate system for locating routes and records, a clear-acetate grid was place over the 1:100,000 mosaic. Solid lines in the grid were 1.0 cm apart thus forming 1.0 cm^2 cells each representing 1.0 km^2. Further subdivisions were made to the point in which squares represented 250 meter on a side (0.25 cm).

Numbers were used for the x-axis and letters and symbols for the y-axis. Smaller 0.25 cm squares were assigned the first 4 letters of the Greek alphabet, clockwise starting from the north. Partial maps in which the island's outline was complete but the grid covered just

Figure 4 Aerial Photograph of 1/3 of Isla Cedros original provided by DETENAL.

a given section, were also produced. These, together with a copy of the aerial photo including the area to survey, were taken along on each trip.

Exact location of the records was then feasible. A portable field stereoscope and the blow-up 1:45,000 photographic mosaic were used to double-check all locations.

STUDY APPROACH

The approach to the field work included four phases; familiarity, extensive survey, double check and intensive study. The first phase involved direct observational methods to develop familiarity with tracks, droppings, and other signs of deer use, and locations and habitats with deer use, etc. The second phase was originally envisioned to concentrate on areas of likely occurrence of deer based on the initial preferred habitat information obtained. Deer signs, however, were recorded in a wide range of habitats. Therefore an extensive survey throughout the entire area of the island was conducted instead, during our 4 months of uninterrupted study (June-October).

In order to better ascertain the actual boundary of the deer range, a "double-check" survey was carried out as a third phase. This implied repeated visits to the boundaries of the distribution of deer over the island obtained from the extensive study. On the basis of this information three

areas were selected for conducting the final intensive study phase (Los Quiotes, La Venada and Puerto Nuevo)(Fig.2).

LOGISTICS

At the beginning of the study the researchers were dropped by fishermen boat on the shore with provisions of food and water. Pick-up dates and places were prearranged. Afterwards, a wooden 2.74 m dinghy built under fishermen guidance and a 5.48 m wooden skiff lent by the local Fisheries Inspector, both motored with outboard motors (9 and 40 HP respectively) constituted the means of transportation.

Backpack trips of two to six days hiking (depending on availability of water supplies and the route or area to cover), were then made from the shore. Base camps to cover a given area were set up in different locations throughout Isla Cedros. The entire island was combed by foot.

PROCEDURES FOR DATA GATHERING

Excursions were made into groves, drainage bottoms, slopes, rocky and steep areas, or onto ridges, etc., over all the six major physiographic regions in which the island was arbitrarily divided (Fig. 5). While deer could

occasionally be seen, most of the information was obtained by an evaluation of their signs. Track length, width and depth, stride length, continuity of track and trails, bedding site characteristics, bed length and width, hair color, height, length and width of antler scrapings on plants, marks left on plants according to feeding mode, number of pellets per group, oldness class of pellets, microhabitat characteristics, bones or fragments found, sounds, and/or any other evidence of the presence of deer in a given area were carefully recorded.

Pellet-count surveys were carried out on all physiographic regions and under every topographic condition within a region (e.g. slopes, ravines, etc.). A starting point was selected at random and the number of droppings per time and per distance were then recorded. The presence of other animals was also recorded. Interviews with local fishermen and other inhabitants of Isla Cedros added to the information obtained. When encountered, deer were observed for as long a period as possible with the aid of binoculars (7X35). When deer were known to be in an area, considerable caution was exercised not to alter their natural routine or behavior. Slow systematic scanning of all visible terrain with binoculars was found effective for locating deer in certain areas.

Activity outlines were sketched in field notebooks and details added as the animal entered relative inactive or constant states. No more than 3 individuals were ever seen

together at any one time, so activity notes and animal characteristics could usually be recorded simultaneously for all. Due to the nature of the terrain one can not move far without considerable accompanying movement of rocks. Sounds of rock fall produced by deer frequently lead to sightings.

Reactions of deer to the researchers were classified in five categories following those proposed by Light and Weaver (in litt.), redefined by Wehausen (1980), and one suggested in the present study.

A comprehensive list of plant species included in the diets of Cedros Island deer were obtained from field observations. Some of this information was derived from direct observations of feeding deer as well as by close examination of plants on feeding sites shortly after departure of deer. All species fed upon and some others present on the area were recorded.

PROCEDURES FOR DATA ANALYSIS

Cedros Island was arbitrarily devided in six major physiographic regions, according to differences in location, aspect, topography, vegetation and ground cover, moisture, superficial water and microclimate (Table 3, Fig 5).

All data obtained during the different phases of the field work were coded and stored on computer files. By

means of developing simple FORTRAN IV subroutines, data were sorted, handled and finally graphically represented (plotted).

Figure 5. Physiographic Regions of Cedros Island

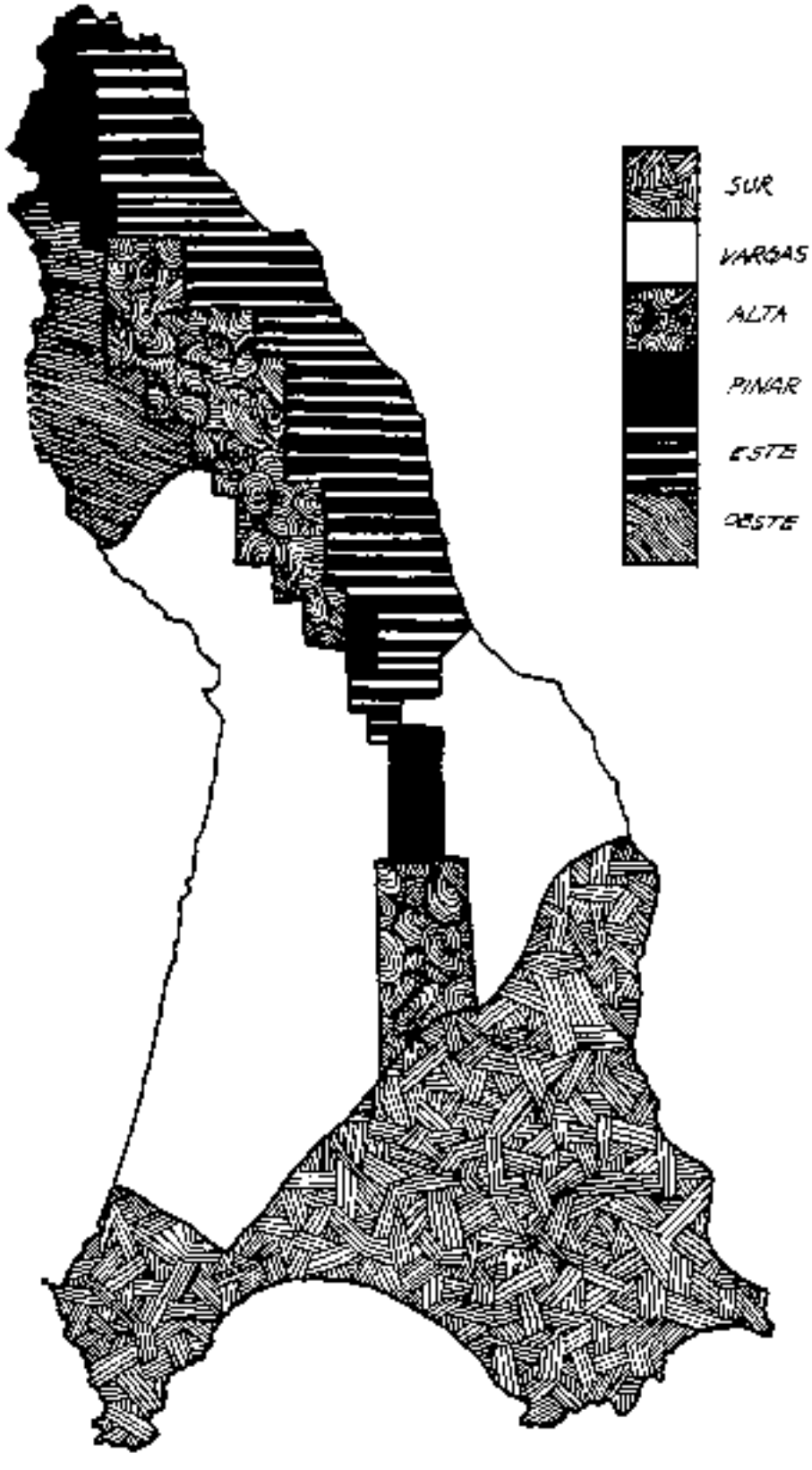

SUR
VARGAS
ALTA
PINAR
ESTE
OESTE

Table 3. Characteristics of suggested major physiographic regions of Isla Cedros.(continues)

Region name	Area (km^2)	% of island	General location	Aspect (exposure)
1 Alto	31	8.62	Mt.Cedros and Gil mountainous masses, higher elevations excluding the forested summits	all exposures
2 Sur	126	34.96	southern portion of the island, south of Mt.Cedros	predominantly S or SE
3 Pinar	10	2.92	divide north of Mt.Cedros, northwest tip of island	predominantly W
4 Vargas	111	30.86	central portion of the island, E and W of Mt.Cedros, SW of Pico Gil	East or West
5 Este	59	16.30	central and northeast portion of the island	predominantly E
6 Oeste	23	6.33	northwestern portion of the island	predominantly W

Table 3(continued). Characteristic of suggested major physiographic regions of Isla Cedros.

Region name	Topography	Vegetation	Superficial water	Others
1 Alta	predominantly steep slopes, ridges, divides and cliffs	desert scrub, juniper woodland, coastal sage scrub, chaparral	origin of major springs, fresh, lightly salted	dry, windy
2 Sur	lowlands, small canyons and hills	maritime dune scrub, open desert scrub, many non-vegetated areas	none	very dry, airstrip, human settlements, villages, road
3 Pinar	divides, cliffs, steep slopes and ridges	predominantly pine forest	none	windy, foggy, moisture highest, afternoon dripping from needles filters through litter
4 Vargas	wide ravines, broken, rocky, few flat valleys	desert scrub, few non-vegetated areas	scarce, salty, bitter, high in minerals, never running down to the shore	dry, moisture higher on west side
5 Este	secondary ridges, narrow drainages, steep slopes, rocky, craggy	desert scrub	common, salty and bitter but potable, running down to the shore	dry
6 Oeste	secondary ridges, narrow drainages, steep slopes, rocky, craggy	desert scrub	common, less salty and bitter, also potable, running down to the shore	moderate moisture, foggy

RESULTS AND DISCUSSION

TAXONOMIC STATUS

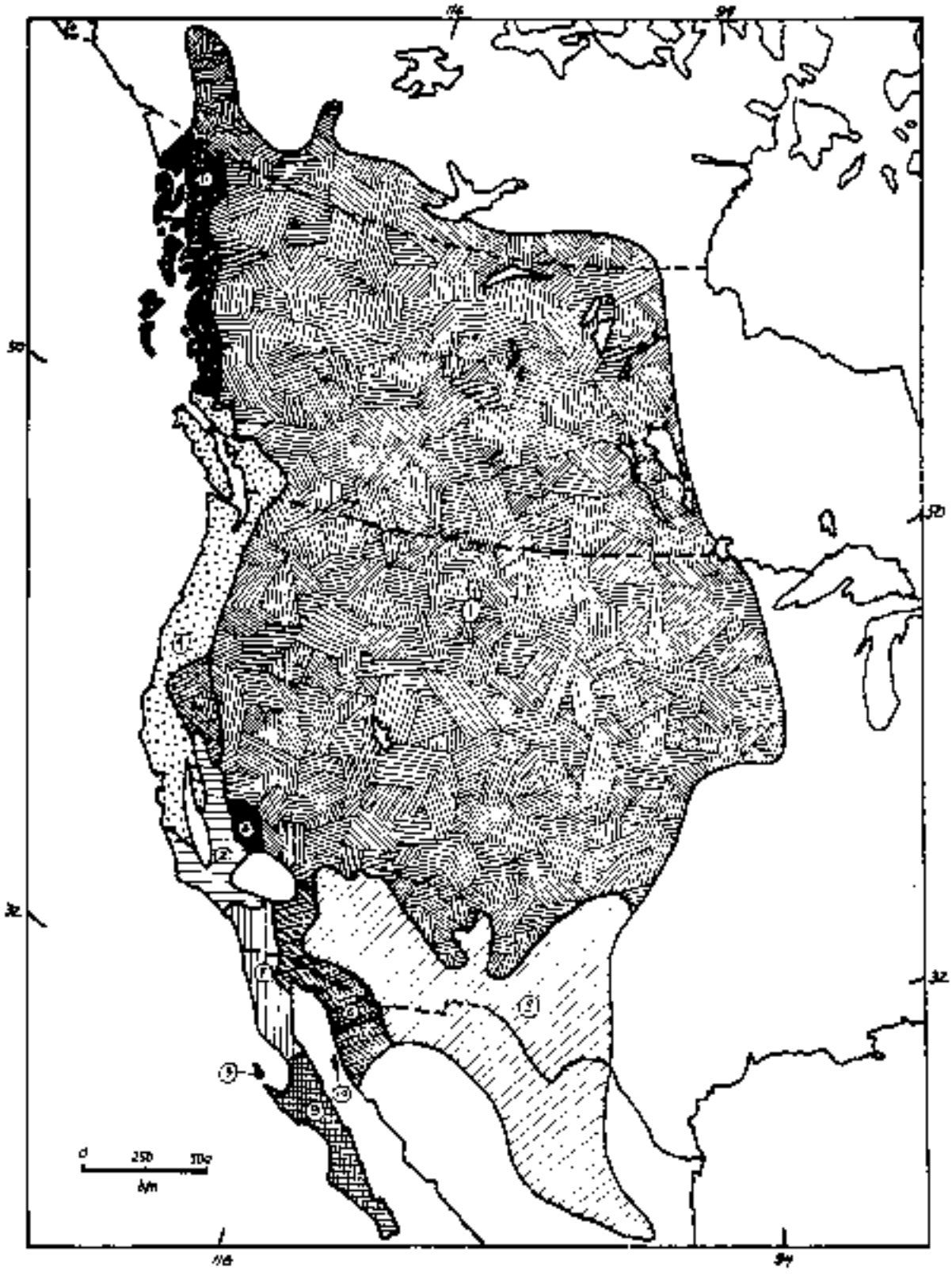
NOMENCLATURE

Cowan and Holloway (1973) correctly stated that a factor not usually considered in discussion of endangered taxa of mammals is the validity of the currently accepted taxonomic status of a species or subspecies. Furthermore, that a critical reexamination of the validity of the nomenclatural recognition of the endangered taxa of deer is very desirable.

The deer of Cedros Island have been referred to mule deer as Odocoileus hemionus cerrosensis. Mule deer (MD) and black-tailed deer (BTD), Odocoileus hemionus, are native to North America. The species originated from a primitive deer that is believed to have come from Asia. The black-tailed and the mule deer are currently given only subspecific distinction (Cowan 1936).

O. hemionus is composed of 11 subspecies whose range extends from the Great Slave Lake (NW territories of Canada) in the north to Isla Tiburon and Cabo San Lucas (Mexico) in the south, and from western Minnesota in the east to the Pacific Coast on the west (Hall 1981, Hall and Kelson 1959, Whitehead 1972).

Figure 6 Distribution of Odocoileus hemionus subspecies


0
250
500
km

Cowan (1956) listed the common and scientific names for the eleven subspecies as follows (Fig.6).

1-Rocky Mountain MD O.h.hemionus (Rafinsque 1817)
2-California MD O.h.californicus (Caton 1876)
3-Cedros Island deer O.h.cerrosensis Merriam 1898
4-Columbian BTD O.h.columbianus(Richardson 1829)
5-Desert MD O.h.crooki (Mearns 1897)(syn.O.h.canus)
6-Burro deer O.h.eremicus (Mearns 1897)
7-Southern MD O.h.fuliginatus Cowan 1933
8-Inyo MD O.h.inyoensis Cowan 1933
9-Peninsula MD O.h.peninsulae (Lydekker 1898)
10-Tiburon Island MD O.h.sheldoni Goldman 1939
11-Sitka deer O.h.sitkensis Merriam 1898

Odocoileus hemionus cerrosensis was the first Cervidae to be described for the Peninsula. Merriam in 1898 named it Odocoileus cerrosensis. Lydekker assigned to it the trinomial nomenclature first as Mazama hemionus cerrosensis (1901) and later (1915) as it is in use up to the present times (Huey 1964). Its currently accepted taxonomic position can be summarized as follows: family Cervidae, subfamily Odocoileinae, genus Odocoileus, species O. hemionus, subspecies O.h.cerrosensis.

Terrestrial mammals other than bats do not easily cross

salt water barriers, and thus whole faunas can diverge if they are isolated by ocean. Perhaps due to isolation, deer on Cedros may comprise a well defined genetic population.

SIZE

Apparently the subspecies of mule deer conform the Bergman's Law in that the individuals of races inhabiting the colder localities are larger than those inhabiting warmer regions. The northern races are not only larger than their southern counterparts but also display greater sexual dimorphism in body size (Boetticher 1915, Vaughan 1972).

Within the mule deer group, the insular form Odocoileus hemionus cerrosensis is of smaller size than either of the races on the immediately adjoining mainland. No instance is known in which an insular form is larger than the related form on the adjoining mainland. Cowan (1936) speculates about the meaning of small size in island populations. A typical mainland mule deer buck stands about 1400 mm and a doe around 920 mm high at the shoulders. These figures approximate the asymptotic shoulder height, which appears to be attained after about 4 years in males and after 2 years in females of mule deer in Utah (Robinette et al. 1977). By indirect measurements such as measuring nearby vegetation after departure of standing deer, or by measures derived from pictures, total length and shoulder

height for the Cedros Island Deer were calculated . Adult males stand about 1033+/-70 mm at the shoulder (n=8) and are about 1600 mm in total body length. Adult females are smaller, around 850+/-53 mm in shoulder height (n=4) and about 1500 mm in total length. Measurements of the adult male type taken from dry skin show the total length to be 1560 mm. Height with head up (top of head) by indirect measurements for one male was 1500 mm and 1080 mm for a female. Thus, body dimensions for both sexes are on the average, somewhat shorter than those recorded for the nominate race O.h.hemionus (Anderson et al. 1974, Cowan 1936 and Whitehead 1972).

Cedros deer appear to be more slender and perhaps lighter in weight than typical mule deer. The latter averaging between 114 to 136 kg live weight (Taylor 1956), while Aguilar (pers. comm.) estimated the weight of a male he shot on Cedros as being about 80 kg. Tinker (1977), on the other hand, reported mainland races weighing little less than 100 kg.

CRANIAL MEASUREMENTS

Skulls of Cedros Island deer found in the field, plus specimens examined at the San Diego Natural History Museum (SDNHM) and at the Museum of Vertebrate Zoology (MVZ) at Berkeley, California, form the sample from which cranial

morphometrics were explored. Cranial measurements were taken to the nearest 0.5 mm, for most measurements, in the manner described by Cowan (1936). Table 4 presents some of the average skull measurements (in millimeters) from adult deer of Cedros Island.

Cowan (1936) summarized the cranial relationships of this race relative to other subspecies of mule deer. Compared with O. h. peninsulae, O. h. cerrosensis has a relatively as well as actually shorter tooth row and individual teeth are on the average narrower. Furthermore, the skull is smaller in all parts measured. The rostrum is not markedly elevated anteriorly.

When compared with O. h. fuliginatus , besides being smaller in all parts measured, cerrosensis differs cranialy in the following selected respects: mastoid width (MAW)is equal to or greater than the orbital width (LOW), upper (UMS) and lower (LMS) molar series are relatively shorter and the elevation of the rostrum (ROE) averaging greater. In certain characters, such as elevation of the rostrum, cerrosensis is intermediate between fuliginatus and poninsulae. Cranial similarities plus other characters possessed by cerrosensis would suggest an origin from a type resembling fuliginatus (Cowan 1936).

Table 4. Average Skull Measurements (in mm) of Adult Deer from Cedros Island.

measurement	symbol	n	mean	+/-s.d.	range
Zygomatic width	ZYG	7	103.54	10.24	94.0-122.0
Greatest width of nasals	GWN	7	25.90	2.35	23.0-29.0
Nasal length	NAS	7	75.41	4.35	71.35-83.0
Upper molar series	UMS	7	67.07	2.88	62.0-72.6
Lower molar series	LMS	7	74.91	3.83	73.5-78.0
Length of Diastema	DIA	7	58.20	3.65	53.3-63.0
Palatal Breadth	PAB	7	45.45	2.46	44.0-50.6
Maxillary width	MAX	5	70.93	4.28	64.45-75.4
Least width of nasals	LWN	5	15.03	2.10	12.6-18.2
Temporal width	TEW	5	64.17	6.09	58.7-74.4
Basilar length of Hensel	BLH	7	229.09	15.59	215.9-257.0
Least orbital width	LOW	6	62.57	2.06	59.75-66.0
Mastoid width	MAW	7	66.84	2.56	63.45-71.9
Post palatal width	PPW	4	26.75	0.96	26.0-28.0
Length of external nares	LEN	4	56.50	2.38	53.0-58.0
Width of external nares	WEN	4	26.50	1.29	25.0-28.0
Width of Pm2	PMW	2	8.50	0.71	8.0-9.0
Elevation of rostrum	ROE	7	36.86	6.25	31.85-50.20
Length of dentary	DEN	4	187.16	17.77	168.55-210.74

ANTLERS

When first described (Merriam 1898), antlers of the Cedros Island Deer were said to branch once only. Further studies revealed however, that the antlers are of the same doubly dichotomous type as in the other races of Odocoileus hemionus.

Interestingly, the brow tine or basal snag commonly present in other subspecies is absent in the Cedros Island deer. Cowan (1936) believes it does not occur at all in the small antlers of this insular race. No exception was recorded after examination of live, antlered bucks, antlers collected in the field during this study, antlers and skulls in museum collections, nor from evidence cited in the literature. Also, antlers of cerrosensis may be thicker at the base, but definitively exhibit less rugosity than that of other races.

Antler phenology of the deer of Cedros resembles that of the Desert mule deer (O. h. crooki) as described by Dasmann and Taber (1956), Swank (1958) and Truett (1972), among others .

For the desert mule deer of Arizona antler shedding was reported to occur from the first half of February through April(Swank 1958, Truett 1972). New antler growth begins in early May. At that time fuzzy knobs are barely visible from a distance. By mid-June antlers are in velvet. In July a

two point buck had dark brown antlers with velvet hanging loosely from its sides. Time of velvet drying and shedding together with antler development and shedding timing seem to be somewhat shifted from the schedules reported for northern races (see Anderson and Medin 1971).

Table 5. Average measurements (mm) of Antlers of Odocoileus hemionus cerrosensis

measure	avge.	+/-s.d.
Greatest tip to tip spread	357.33	16.17
Greatest outside spread	428.67	49.65
Circumference one inch above corona	96.25	7.93
Primary fork to anterior secondary	109.25	12.50
Primary fork to posterior secondary	115.50	28.05
Corona to tip of anterior prong	429.67	15.01
Corona to primary fork	173.75	14.38

With respect to size, the antlers of cerrosensis resemble those of the coastal Columbian black-tailed deer. They have comparable tip to tip spread,greatest outside spread, etc., both subspecies being markedly smaller in all measurements than those of other races in the genus. The angle through which the antlers are twisted inwards seems to be less pronounced in the Cedros Island Deer than in the other races, and is definitively so if compared with the white-tailed deer.

EARS

Ears of mule deer may well extend over 200 mm in length (Wallmo 1981). For the deer of Cedros ear length from crown anteriorly was 180 mm (Cowan 1936). The outside margins of the ear of Cedros Island Deer present a distinctive dark brown line of hair that fades as it blends into the pelage of the tip (up) and of the base (down). In at least one individual, the inside margins also showed a somewhat darker coloration.

TAIL

Tail shape and color pattern vary markedly geographically (Cowan 1936). Except in areas of intergradation, the external form and color pattern of the tail provide a fairly reliable and readily appraisable means of differentiating certain kinds of deer in life.

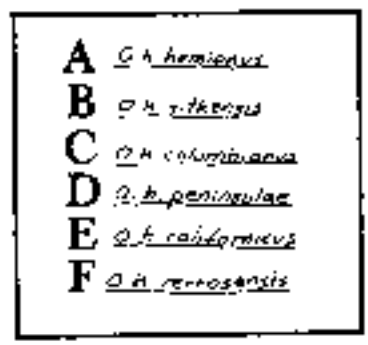
All mule deer have shorter tails than the white-tailed deer (292 mm average length). They average close to 178 mm in length, and always have a black tip. Several subspecies have various amounts of black on the upper surface of the tail (Fig.7).

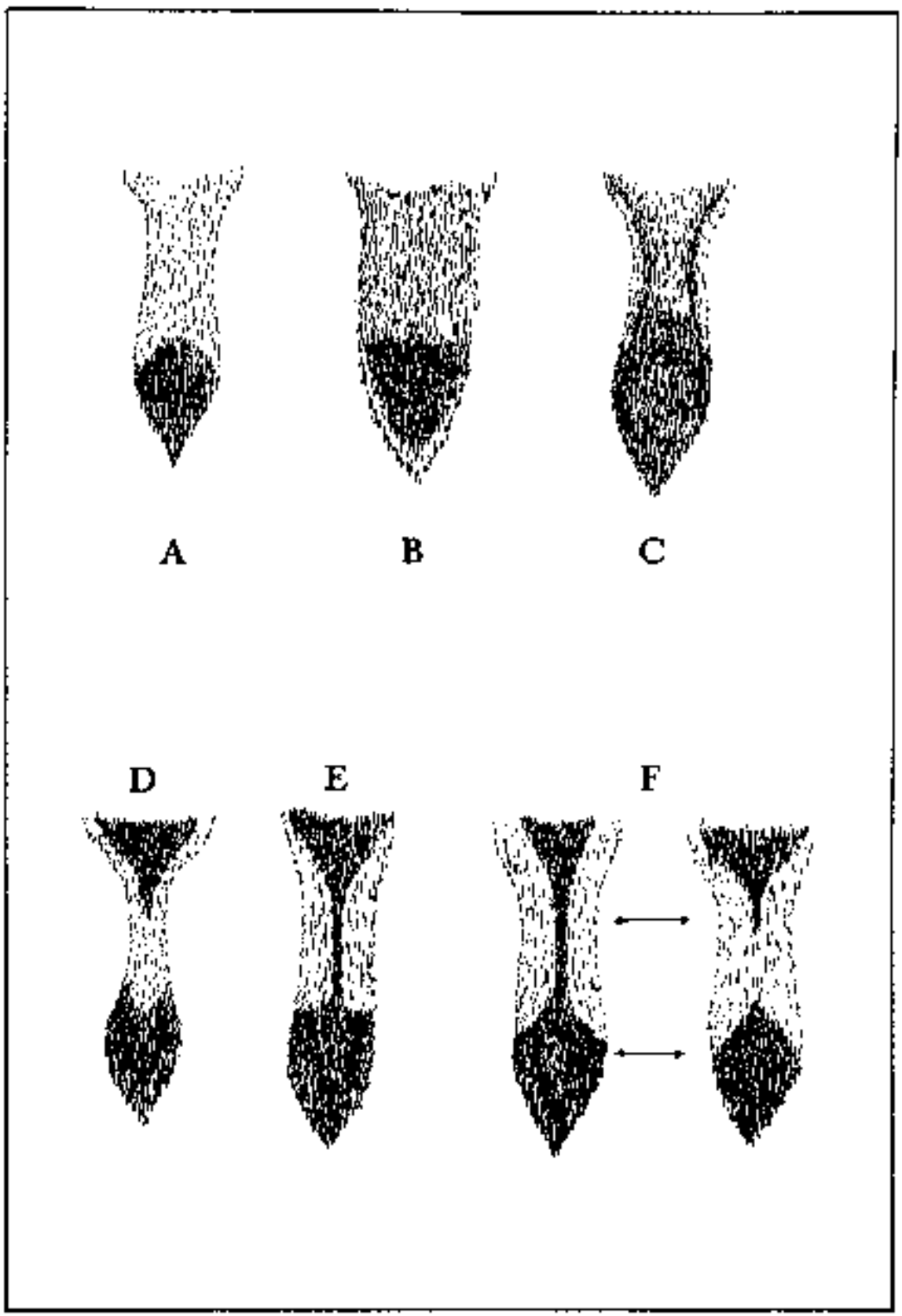
Tail length of the Cedros deer was 180 mm, thus within the range of variation for the species. Tails of Cedros

deer are broad at the base, constricted in the middle, and distally, ending in a V-shaped tip. In one individual however, no medial constriction was evident. The tail was almost straight-sided. In this race a little more than one third of the dorsal face of the tail on the distal part is dark brown, appearing black from the distance. When seen from one side, a long haired terminal brush becomes evident.

One of the most prominent characters possessed by O.h.cerrosensis is a dark brown stripe extending down the entire length of the dorsal side of the tail. Proximally the dark-colored hairs blend into the pelage of the sacrum. Whereas in most of the animals the dorsal dark-brown stripe extends well down the tail, its width and length varies. In three individuals the stripe was a very narrow continuous line (10-20 mm estimated width). In five other (4 does and 1 fawn), the stripe was interrupted. A short line formed as a prolongation of the distal dark-brown diamond, blended into the lighter pelage more or less half way upward. Another interesting departure was the broadening of the tail stripe at the base, as seen on a fawn. This is an inconsistent character in other members of the mule deer group, the dark line being of varying width and intensity, and extending down the dorsal tail surface for greater or lesser distances (Fig.7).

Figure 7
Tails of Odocoileus hemionus




A
B
C
D
E
F

No variation in tail length, shape or color among sexes was noticed or has ever been reported for this race. The dorsal dark-brown stripe, albeit distinct, gradually grows paler towards the margins. The tail is heavily and fully haired with light reddish-brown or beige colored hairs, set off quite distinctively against the middle dark line and the dark-brown terminal brush. The lower surface is covered with long buff or beige hairs. While in other subspecies tails are either fringed or flecked with white hair, tails of the Cedros deer have no white parts at all, and no exception to this was noted.

PELAGE AND MOLT

Pelage succession and types of hair seem to be fairly constant within the genus Odocoileus (Cowan 1936). The typical color pattern for the Cedros Island Deer varies from light cinnamon and reddish brown, to beige, gray and grayish-brown dorsally, underparts being lighter. A long dark-brown stripe runs from the forehead, between the eyes back to the rump and extends down the tail. In some individuals the stripe at about one third of its length towards the back, turns to a diffuse countershade to reassume its pattern again at the rump. At least three of the deer observed on the island and 2 skins examined showed this variation (skins from the SDNHM)

On July 23, a fawn had an irregularly spotted coat on the shoulders, loins and hips. Buff-colored hair in distinctive spots contrasted sharply with the reddish brown pelage.

The very small size of the rump patch, washed with buffy brown (usually white in other races), and the dark brown stripe down the dorsal surface of the tail are among the most prominent of the characters possessed by O.h.cerrosensis.

Facial markings include a patch of a somewhat triangular shape, of dark-brown hairs at the base of the nose. A similar patch in the forehead starts as minute thick whorls of dark-colored hair in front of the eyes, extends between them and continues over to the neck, where it widens to the typical dark brown dorsal stripe.

Dark rufous hairs were usually present surrounding the base of the antlers. Undertail, anal, and inguinal areas are covered with light beige relatively long and fine hairs. Behind the front legs for a short distance on each side, and between them to the chest, some individuals presented streaks or patches of relatively darker hair. This condition was also present in the upper surface of the rump where the dorsal stripe merges down into the tail.

Isla Cedros deer undergo an autumnal molt in August and September, as does O. h. californicus and the other subspecies inhabiting California. By August some

individuals already exhibit a well grown fresh winter pelage, with some of the old hairs of the summer still clinging to the sides. The white rump patch (seen in other races) is absent in both summer and winter pelages.

The molt follows no definite sequence as regards areas of body involved. New hair grows more or less evenly over the entire body surface and is fairly well developed before the shedding of the old pelage exposes it to the action of the environment. At any one time in any locality, deer will be found in many stages of molt, regrowth or wear of the pelage, and it is these factors which explain most of the observed color diversity. These are variations due to individual differences in time of molt rather than variations in the color pattern as a whole. When the hair is short, a dark color prevails due to the predominance of the black tips, but as the hair increases in length, the color becomes lighter.

FIELD SIGNS

TRACKS

Cedros Island deer tracks follow the pattern described by Murie (1954) for other North American deer in the genus Odocoileus. They are typically heart shaped imprints of various sizes depending on the age and sex of the animal

that produces them, on the mode of locomotion, and on the substrate on which they are found.

Caution should be exercised in interpreting track measurements. The tracks of juvenile males may fall in the female category whereas those of large and/or old does may appear to be in the range of the measurements for bucks. This introduces a major difficulty in trying to distinguish sexes and/or ages from tracks (Table 6).

For the case of the Isla Cedros deer, length of the track and width of the right toe seem to be fairly consistent within each sex category. Measurements were taken to the nearest 0.5 mm from fresh tracks left by 28 observed animals. Average measurements recorded are shown in table 6.

SCATS

Animal scats provide valuable information to the field biologist. Often, their value is overlooked since methods providing direct data (i.e. first hand information), when applicable, are preferred. However, while valuable, indirect methods as a rule, need to be interpreted cautiously.

Preservation of pellet-groups through time depends upon time of the year (season), microhabitat, dung beetle activity, moisture, solar radiation, wind, etc. For any

Table 6. Average track measurements (in mm) from observed Cedros Island deer[a]

Sex/Age	Length+/-s.d.	Width+/-s.d.	Right toe+/-s.d.
male	60.3+/-3.4	49.4+/-2.8	23.4+/-1.3
female	49.9+/-4.7	41.3+/-4.3	18.3+/-1.7
fawn	39.5+/-3.6	34.9+/-5.3	16.1+/-2.9

[a] n=26 for males, n=26 for females, and n=18 for fawn.

type of analysis and/or interpretation, freshness of droppings is crucial. Fecal samples were counted and collected fresh from observed deer at all oportunities. Fresh droppings have a not unpleasant sweet odour. Back-dating the time of deposition of scat becomes an important step in using this method.

Typically, droppings of Isla Cedros deer had around 125+/-39 pellets per group (range 64-221 n=100) and weighed 26+/-10 g (dry weight for n=100 "recent"). Individual pellets are cylindrical in shape averaging 11.8+/-1.3 mm long and 6.3+/-0.3 mm in diameter (n=100 "recent").

Naturally, pellet characteristics form a continuum, and sharply distinctive categories are arbitrarily set as tools for grouping and analyzing data. Smith (1964) demonstrated the futility of using the number of pellets per pellet-group to distinguish between fecal deposits of individual animals. One is dependent upon general size, shape and coloration of individual pellets to determine the limits of a pellet group. Although some overlap in color, gloss and texture between different pellet groups occurs, oldness or age class assigned accounts for the dominant characteristic seen within a single group (Table 7).

Pellet group counts for estimating deer numbers have been conducted extensively. Knowing the defecation rate of the animals involved is essential to estimate the number of deer from the total scat count.

Even though defecation rates are known, their

Table 7. Dropping characteristics and suggested oldness classes.

Oldness class	Symbol	Texture and condition	Colour	Gloss	Odour
Very old (max.6 m>.)	MV	heavily cracked, crumbly, powder grained, dry, very inflated	light gray to white	dull-opaque	none
Old	V	cracked, more compact, fine grained, dry, slightly inflated	brownish dark gray	dull-opaque	none
Transitional	T	superficially cracked or uncracked, corrugated, compact, dry, not inflated	purple-brown	dim-shine	none
Recent	R	slightly wrinkled or smooth, compact, hard crust, some moist inside	dark brown	shiny	subtle musk-like
Fresh (0-1 day)	F	compact, smooth, soft crust, moist	dark brown to dark green	shiny	sweet musk-like

application depends upon the investigator's ability to obtain reliable data. Factors such as failure to find pellet-groups and destruction of fecal material on the ground can not be ruled out as major causes of error. Many defecation rates have been calculated for mule deer for different areas and seasons (9.7, 12.7, 13.0, 13.2, 14.1 and 20 pellet-groups per deer daily, Neff 1968). Some factors which are believed to cause variation in defecation rates include: i)range condition, ii)relative feed intake, iii)moisture content in forage, iv)changes in diet, v)percentage of fawn(given that fawn after weaning show higher rates than adults), vi)Psychological effects of captivity (if that is the case).

The data obtained by Smith (1964) indicate probable defecation rates somewhat higher than the 12.7 pellet-groups suggested by Rasmussen and Doman (1943), that for years were taken as valid. It appears that from 13 to 14 pellet-groups per day per deer might encompass true values under most field conditions (McCullough pers.comm.).

Deer regularly void waste products at any time of day or night. Ordinarily, they defecate after rising from a rest and then urinate a few minutes later. A deer may defecate when walking, standing or feeding, usually without modifying its activity (Linsdale and Tomich 1953). In waste elimination by a standing buck, the back was slightly bowed as the tail is raised to an almost vertical position. The

terminal third of the tail was bent downward thus giving it also an arched appearance. After defecation-urination, the body reassumed normal length and tail slowly sank to its relaxed, pendant position.

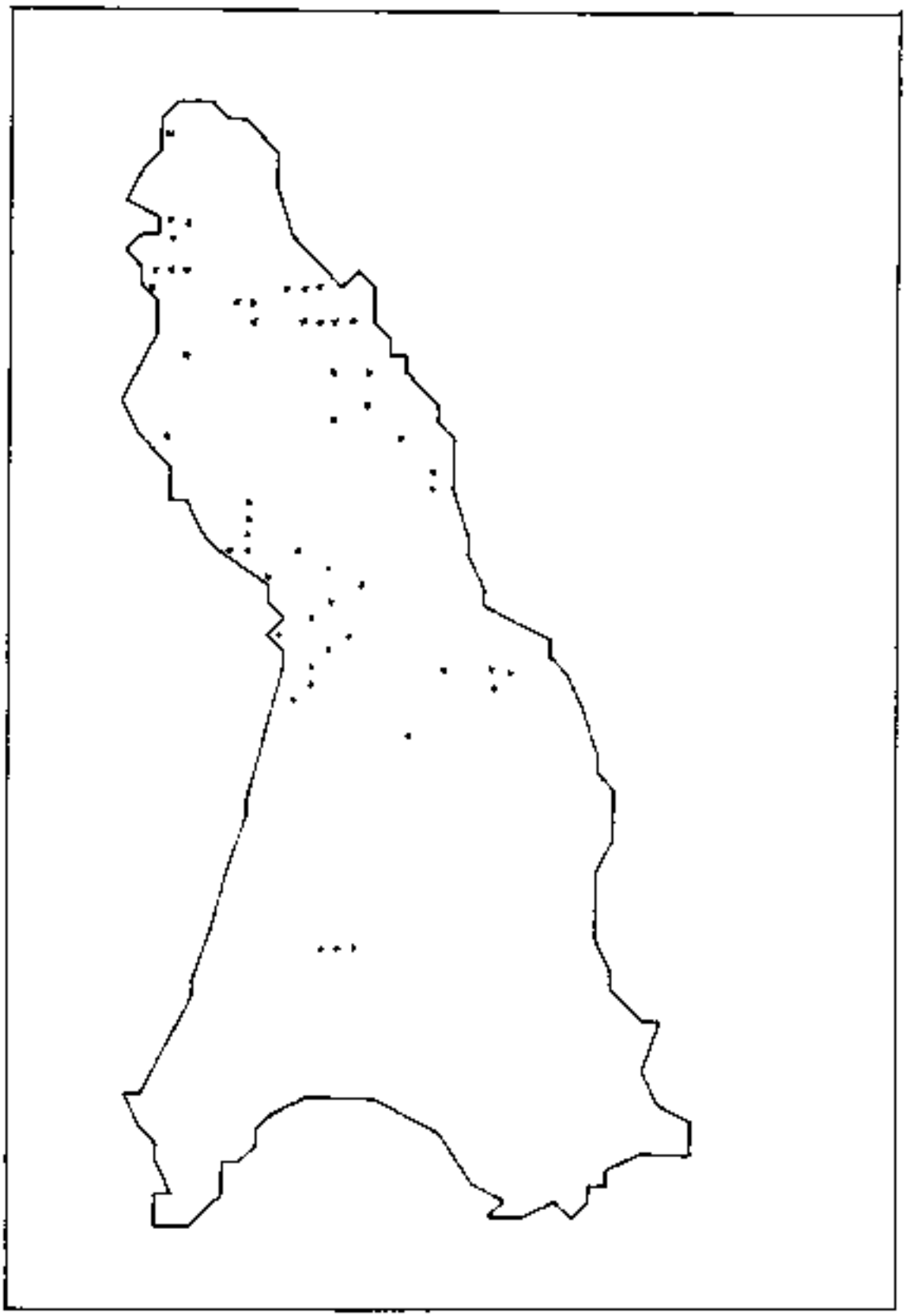
BEDS

Deer examine a site carefully before bedding. They often lower their nose as if to smell the ground and search the site with the eyes. Apparently, less care is taken in choosing a bed on open ground than on litter, sticks or stones (Linsdale and Tomich 1953).

On Cedros, beds are located at the base of a tree or tall shrub on the downhill side and parallel to the contour so that the animal's body is level. By pawing and by scraping of soil to downhill side produces a level floor on steep slopes.

Beds of deer conform closely to the size and shape of their bodies. With continuous use, beds gradually are worked deep into the soil. Typical beds of the deer of Cedros Island are oval in shape, averaging 82.31+/-19.69 cm long and 57.70+/-13.56 cm wide (n=111), ranges 60-200 and 20-110 cm respectively. Beds are in their own right unambiguous sign of deer; moreover, invariably hair, and sometimes tracks were found in or by beds. Beds were found throughout the deer range on Cedros, being perhaps

Figure 8. Bedding Sites throughout the Deer Range on Cedros Island



relatively more abundant towards the northern portion of the island (Fig. 8).

Little more than 70% of all beds examined were on slopes of various aspects and varying steepness (Table 8). Beds on drainage bottoms made up about 20% of the total count. This includes beds at the base of slopes on the margins of the river beds (13.68%), those by the shore on coarse stone beaches (3.16%), and the ones at the centre of the river bed (3.16%). Other beds were found on mountain ridges (9.47%).

Table 8. Percentage of Beds according to their relative position.*

position	number	percentage (%)
Base of slope	16	13.68
Centre river bed	4	3.16
Beach/shore	4	3.16
Slopes	81	70.52
Ridges	11	9.47

*n=116

On the other hand, beds were also grouped according to the nature of the substrate on which they were made and according to the kind of protection or cover element of the environment deer uses for shelter (Table 9). About 13% of the beds were almost in the open, on rocks (3.85%), on fine-grained soil or sand (5.38%), or over alluvium (3.85%).

These beds have usually one or two small bushes if any in their perimeter. The genera Franseria, Euphorbia, Juncus, Ephedra, Eriophyllum, and rarely Agave being the most common delimiting shield plants.

Table 9. Percentage of beds according to the nature of the substrate and protection elements.

Substrate/shelter	Number	Percentage (%)
Amid vegetation	3	2.32
Pine litter	10	8.44
Over rocks	4	3.85
Alluvium	4	3.85
Fine-grain soil	6	5.38
Base cliff-cave	19	16.15
Base tree-shrub	69	60.00

*n=115

Beds on forested areas, mainly found over pine-needle litter, account for 8.44% of the total. Few beds were found virtually surrounded by dense plant cover (2.32%).

The protection especially against heat and wind offered by the few arboreal plant species seem to be chosen preferentially by deer. Sixty percent of all beds were found at the base of trees or tall bushes. Plant genera favoured by deer include, in descending order of importance, Pachycormus, Rhus, Simmondsia, Tamarix, Adenostoma, Quercus, and Ceanothus.

Little more than 16% of the beds were found in caves or under roofs made by prominent rocks or at the base of cliffs

that secure shadow and wind shield. Beds are normally associated with trails. A total of 6 "double-beds" were found. These were contiguous beds under the same tree, shrub or rock.

FEEDING SIGNS

When they are grazing, deer may break off vegetation either with an upward or downward motion of the head. The lips are used to bring food into the mouth (Linsdale and Tomich 1953). Deer leave ragged, blunt ends on plants from which they take food, and they never make the sharp, angular cuts characteristic of rodent feeding.

The most important plant species fed upon by the Cedros Island deer are listed below. Species are presented in decreasing order of importance according to frequency recorded.

Pachycormus discolor

Simmondsia chinensis

Rhus lentii

Acalipha californica

Xilococcus bicolor

Arctostaphylos bicolor

Ephedra aspera

Rhus integrifolia

Eriogonum molle

Eriogonum pondii

Baccharis sarothroides

Tamarix pentandra

Pentstemon corrosiana

Galvesia juncea

Perityle emoryi

Future microhistological analysis of fecal samples and perhaps the application of many other methods reported in the literature, may lead to determination of the food habits of this deer.

BEHAVIOR

SELF GROOMING

Deer were seen displaying self-grooming behavior. Deer nearly always lick themselves on the hind legs or stretch after rising from a bed. One buck in particular dressed his coat by licking with firm strokes and gradually progressing upward on the body. A deer can reach its shoulders, forelegs, flanks, hips, loins, perineal region, and tail with the tongue. No mutual grooming was observed during this study.

Linsdale and Tomich (1953) wrote that deer groom by

licking, mouthing or biting and by scratching with the hind foot. The hind foot was seen in use for grooming the head and neck. The growing antlers may be also used for grooming the perineum, but hard antlers were never observed to be used for this purpose. Biting is used to relieve itching, to smooth or clean the hair, and to dress the base of the tail.

VOCALIZATIONS

Snorts were heard under various conditions. The snort is produced by expelling air through closed nostrils, causing them to vibrate. It is frequently given by deer before retreating or when approaching a suspected danger. In its simplest form, the snort is used in agression according to Cowan and Geist(1961).

Snorting is closely associated with wariness. Does readily snort, but bucks are more likely to retreat without vocalization, as observed for white-tailed deer by Hirth and McCullough (1977). Does called their fawns on repeated occasions with a one-syllable sound, half a snort, half a bleat. When on the move, does follow the fawn and vocalize and after every three emissions (2-4 seconds) paused before restarting.

Another sound produced by the deer of Isla Cedros was a mechanical sound produced by ear-clapping. Ears are capable

of a strong lateral flapping motion. When the head is shaken, the motion of the ears becomes quite violent and even audible, as the ears strike against each other and against the sides of the head.

USE OF ENVIRONMENT

Environment is not uniform, but consists of a complex mosaic of microenvironments. As a general rule, few terrestrial mammals can withstand the most extreme temperatures of the (typical) habitats they occupy, but are able to select microenvironments in which temperature extremes are moderated.

Because the main axis of the backbone of the major mountain range of Cedros lies north and south, the drainage systems are oriented approximately east and west, and the canyon walls face roughly north or south. The sun's rays strike a south-facing slope more directly than a north-facing slope. The former are consequently drier and warmer than are nearby north-facing slopes.

In agreement with what Truett (1972) reported for mule deer in Arizona, activity and hence behavior of the Cedros Island deer may be influenced by topography. Topography causes unequal distributuion of deer over large areas and determines local changes in distribution given the variations in air temperature and solar radiation.

Presumably, topography influenced deer distribution and behavior in two ways: (1) directly, by affording a means of thermoregulation (comfort seeking), and (2) indirectly, by affecting vegetation availability, palatability and quality in several ways (food seeking). The effects of steepness of slope and exposure are strongly reflected by the plant composition, thus allowing differential use in time of a certain area by deer, and by sympatric herbivores.

ACTIVITY PATTERNS

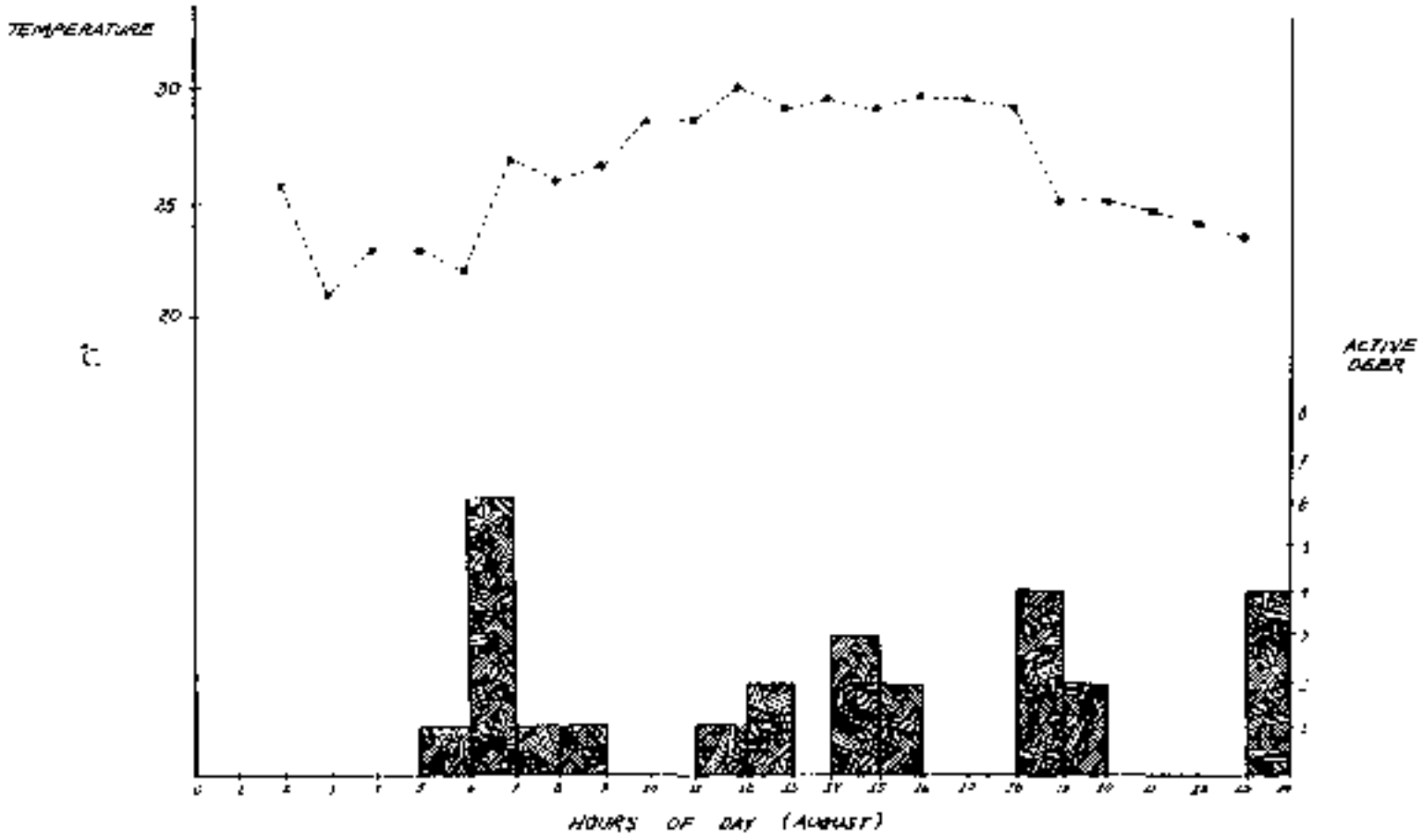
In the literature deer are reported to be more active at dawn and dusk, and rarely active during mid-day (Swank 1958, Taber and Dasmann 1958). Truett (1972) stated that the day temperature affects deer activity during most of the daylight hours. He described an inverse relationship in which an increase in temperature resulted in a decrease in activity and vice versa. The inverse relationship implies also a differential allocation of time for feeding and resting relative to changes in temperature. Deer fed more throughout the day during cool days than they did during hot days. The combined factors of insects and heat often force deer to seek shelter during the daylight hours. Deer seem to remain active about the same length of time after sunrise, regardless of air temperature or time of year (Truett 1972).

Encounters with deer during all four months took place more frequently between 11:00 and 15:00 hours. Therefore, the number of active deer per hour per day can only be derived from a month-by-month analysis. Monthly differences in average daily temperatures may also account for differences in estimates of time of activity between a cumulative versus a month-by-month analysis, such that the difference observed between the cumulative frequencies for all four months and the by-month frequencies may be the result of a bias of data towards mid-day hours.

In this study more deer were observed in August than in any other month. When deer activity records for August are compared with the average temperature per hour per day of the same month, dawn and dusk stand as the times of highest deer activity (Fig.9).

A close examination of their activity in relation to day time temperature for that month shows three peaks in activity, dawn and dusk and midnight . The limited information available suggests that deer on Isla Cedros are more active between hours 06:00 to 07:00,18:00 to 19:00 and interestingly between 23:00 to 24:00. Feeding, antler thrashing, grooming, forehead rubbing, traveling, and bedding were among the activities recorded during those time intervals.

Figure 9.Activity and Temperature in August


TEMPERATURE
30
25
20
°C
ACTIVE
DEER
HOURS OF DAY (AUGUST)

FEEDING BEHAVIOR

Deer were observed feeding at all hours of day and in a few instances even at night. Yet they were more active from the 11:00 to the 15:00 hours. Alternation of feeding and resting was common among deer during this time interval. When deer were not at rest, they were usually foraging. Even while moving to some specific place to eat, rest or other activities, deer commonly fed along the way.

Feeding is a frequently interrupted activity. Idly standing or walking individuals are commonly around those that feed. Nevertheless, feeding activity tends to be coordinated. One deer may get up and start to feed and then another may get up and start to feed. The reaction may spread throughout the group.

Deer cover little distance while actually feeding and tend to move from one bush to another. An animal usually starts to feed in the vicinity of its bed, soon after it gets up (Linsdale and Tomich 1953). Leaves, shoots of the browse plants, forbs and grasses constitute the bulk of their food (See section on Feeding Signs for a list of plants found to be fed upon by Cedros Island deer).

RESPONSE TO INTRUDERS

Deer are inherently wary of intruders and strange objects in their surroundings. They show considerable variation in their response to approach by and to man . This variation may be caused by past experience, physical conditions of the environment, mode of approach by invertigator, relative juxtaposition, or individual differences resulting from sex, age and season (Linsdale and Tomich 1953). Typically an alert deer tends to be perfectly still before acting or moving. The animal will study the cause of disturbance and wait for it to act. Impatience or fear may finally drive the deer to action (Clark 1953). Fear of man can be overcome largely by constant close association, particularly if man does not disturb the deer.

The most common reaction towards an intruder, as presented in the literature (Wallmo 1981) is an immediate flight in a stiff-legged bound for 10 to 20 leaps. The individual may then stop and watch the intruder for a period of time before walking or trotting out of sight (Clark 1953).

On Cedros, those bedded deer that sensed the approach of the observers got up in a sudden stiff-leg jump and froze at the spot, watching the intruders. Deer occasionally used the bounding gait described by Linsdale and Tomich (1953) in descending very steep slopes.

Dixon (1934) stated that bounding temporarily gives deer a better vantage point from which to view a pursuer. In agreement with what Linsdale and Tomich (1953) considered a gait of deer that are hurried but not frightened, the slow run was a common gait performed by deer. They first fled at a walk, stopped at a distance, and after watching for some time, slowly ran to nearby escape cover.

Distance of observation of deer varied considerably as a result of the multiple topographic conditions of the island. Deer were observed from less than 3 m to 500 m. Distances were determined by three alternative ways; the use of a range finder (0-100m); with reference to landmarks in the terrain; or by approximations drawn from the distance ring of telephoto lenses. Long distance observations were more the exception than the rule. Therefore, the mode rather than the mean distance of observation best reflected the distance at which deer were encountered on Cedros Island.

The distribution of the distance of observation for fawn was bimodal with modes at 0-10 m and 140-150 m intervals. Data for males were unimodal, with the mode being the 10-20 m class interval whereas those of the females were bimodal, with peaks at the 10-20 and 90-100 m intervals.

Reaction of the Cedros Island deer towards the observers can be broken into five discernable categories. The following categories were first proposed by Light and

Weaver (1973 in litt.), redefined by Wehausen (1980), and slightly modified in the present study.

(1) unconcerned: animal demonstrates knowledge of the investigators presence, but does not change basic behavior patterns of feeding and bedding.

(2) curious: animal stands and watches the investigator at times but otherwise continues feeding and bedding activities.

(3) bold: animal stands first, then approaches, stays considerably close watching the investigator; could also be taken as cases of extreme curiosity.

(4) concerned: animal stands and watches the investigator considerably, may feed some, but will not bed, this constitutes a delayed flight.

(5) immediate slow flight: animal departs immediately at a walk.

Reactions falling into Wehausen's fifth category (immediate fast flight, flight on the run) were not recorded for the Cedros deer (Table 10).

Table 10. Reaction of deer to the surveyor.

REACTION	Male	Female	Fawn	Total	Percent (%)
Unconcerned	3	9	3	15	35.71
Curious	2	-	-	2	4.76
Bold	2	4	2	8	19.05
Concerned	3	4	-	7	16.67
Slow flight	3	5	2	10	23.81

The reactions observed suggest that 76.19% of the deer (unconcerned, curious, bold and concerned) were to varying extents tolerant of the odour and sight of humans, whereas the remaining 23.81% (slow flight) were not, and fled immediately.

The observed high tolerance to humans, together with the short modal distances of observation, are interpreted as the outcome of little previous contact of deer with humans. This condition is hardly ever observed in heavily hunted populations (Kucera 1976).

Cumulative time of observation for all three sex and age categories was 22 hrs. 40' . Average observations time per animal was 32 min, reflecting the time deer tolerated the persistent observation of the investigators.

A disturbed deer often stamps one or both feet upon the ground. The forefoot is raised slowly and then brought down sharply. Stamping was usually accompanied by snorting. Linsdale and Tomich (1953) considered it as a movement of aggressive defense or threat and that resembles an attack, which is climaxed by striking with both feet.

In July, a four-point adult male, after stamping both front feet vigorously, charged on the run towards the observer from about 30 m away, running and leaping with the head just above the shoulder level. He ran about 20 m, and then suddenly stopped and froze. After 8 min the buck

turned around and continued his former slow walk.

In general, as deer withdrew from the observer, their tails were held in contact with the body, not dropping freely but forced against the perineal region. Cedros deer often bobbed their heads possibly in response to the investigator being still an unidentified possible danger. The head is quickly lowered from well above shoulder level to near or even lower shoulder level, and then rapidly returned. Linsdale and Tomich (1953) believed that head bobbing was an effort to cause the strange object to move. A deer may move its head from side to side when studying the pursuer. Obtaining a view from several different angles may aid recognition and depth perception (determining the distance between deer and object) (Dixon 1934, Myers pers.comm.)

POPULATION DISTRIBUTION

DEER SIGHTINGS

Out of a grand total of 52 sightings, a total of 42 individuals were considered as the "minimal number" of deer observed. This includes 22 females, 13 males and 7 fawn.

During the study period, Cedros Island deer were seen as solitary animals (47.62%), or in 8 groups of two (36.10%), or 2 of three individuals (14.29%). Both trios

had two adult females, in one case accompanied by an adult male and in the other by a fawn. The eight pairs were constituted as follows: doe-doe, fawn-fawn, two buck-doe and four doe-fawn.

Minimal number of deer observed per region are presented in table 11. About 43% (18) of the deer were on north or northeast exposure slopes (Fig. 10). Although, north and northeast facing slopes and others that faced away from the sun seemed to be favored for bedding and feeding in hot days, there was no strong preference for any particular exposure, at least at this time of year.

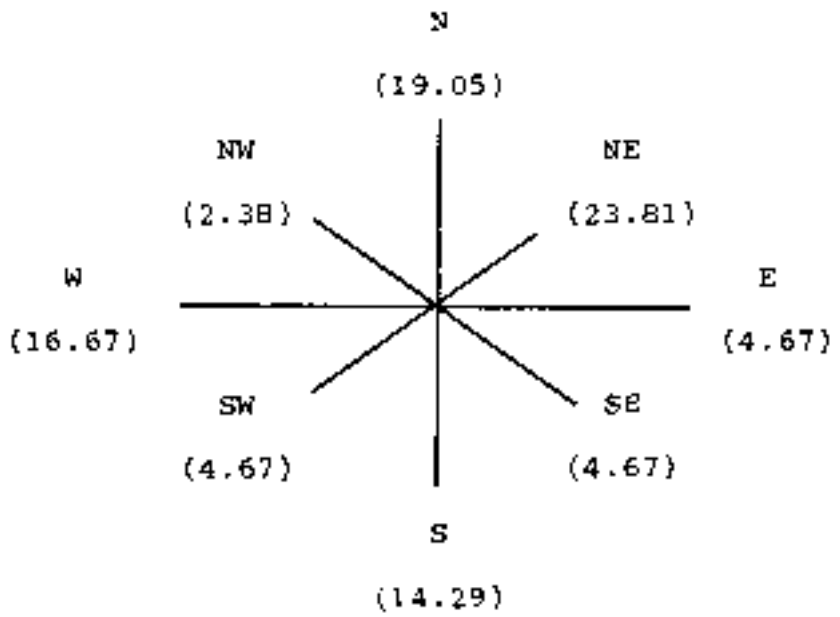
Vargas accounts for 42.38% of all records; Este, 26.42%; Oeste, 19.87%; Pinares, 7.75%; and Alta 3.58%. Differences are attributed to the difference in size (area) of the regions and to the subsequent variation in field-effort(in time) for each.

Table 11. Deer observed per Physiographic region.*

Physiographic Region	Minimal Number	Percent %
Alta	1	1.92
Este	20	38.46
Oeste	12	23.08
Pinar	6	11.54
Sur	0	0.0
Vargas	13	25.00

*100%=52 deer

Figure 10. Percentage of deer observed per slope aspect.



The entire extension of the island was searched for deer and deer sign. Whenever encountered, exact location was determined by using the partial field maps and the aerial photographs. Evidences of deer presence included, actual sightings, bones, antlers, skulls, hair, beds, trails, tracks, scats, antler marks on plants and evidence for feeding.

All locations of signs were plotted following the aforementioned coordinate system. Each point (symbol) in a figure may represent as many as 50 records. The entire range of Odocoileus hemionus cerrosensis, covers 234 km^2 (23,400 ha), approximately 65% of the total extension of the

island (Fig.11). Southernmost limits of the deer range as obtained from the initial survey were double-checked to obtain a more realistic boundary, as shown in Fig.11.

At one time, deer from Cedros were said to be "...confined to an area of pine forest and chaparral in the southern sector of the island..." (Cowan and Holloway 1978). However, as it has been pointed out herein, pine forest and chaparral are not found in the southern portion of Cedros. Instead, deer seem to be distributed rather evenly throughout the island, except for their absence from the southern section.

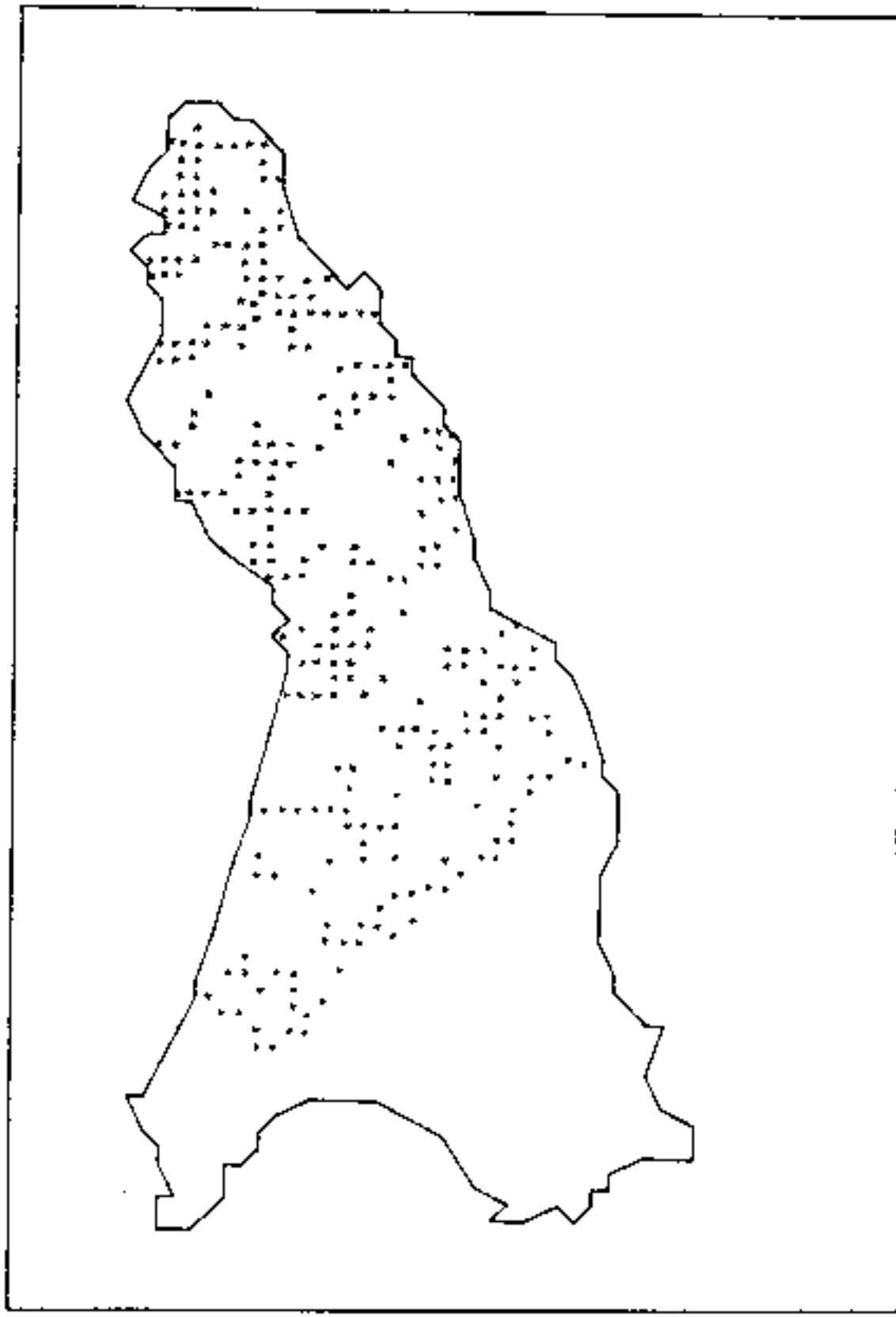
According to local residents, deer never roam in the southern portion of the island. Two exceptional cases (of deer sightings) were reported however, the last of which, took place more than 10 years ago (Muñoz and Arce pers.comm.). No sign of deer of any kind was found in the southern region.

POPULATION SIZE

ESTIMATE OF NUMBERS

The pellet-group count survey was the method used to estimate the abundance of Cedros Island Deer. As stated by Neff(1968), pellet-group counts are not a panacea or a

Figure 11 Distribution of Odocoileus hemionus cerrosensis over Cedros Island, B.C. Mexico.



shortcut to big game population data. However, it does appear that they can be used to obtain reasonable estimates under most field conditions.

Pellet surveys are useful in that they can be used to estimate deer populations on areas of virtually any size. Pellet group sampling is more efficient in areas of high pellet-group density. Van Etten and Bennett (1965) warn surveyors on some common sources of error in using pellet group counts for censusing deer.(1) missing pellet groups by overlooking them (2) interpreting a pellet group as old when it is new or vice versa, (3) counting a single group as two or vice versa, and (4) counting other than deer pellets (e.g.goat pellets).

Because of error due to missed groups, field counts almost invariably produce an underestimate of the mean pellet-group density. The effect of an increase in the defecation rate will be to lower the estimated total numbers of deer or deer days use, also causing an underestimation of deer numbers. In this study, a defecation rate of 13 (times per day) was used.

Transects were run throughout the deer range. With belt transects is desirable that as much variation as possible be included within each transect, and as little as possible between transects. This was accomplished by running transects diagonally across the drainage pattern so that all slope exposures were sampled by each transect.

Records per time and distance were made for droppings found in any locality. The mean of all sighting distances (perpendicular to an hypothetical line on the ground), was used to calculate strip width. Area was then calculated by simply multiplying by transect length.

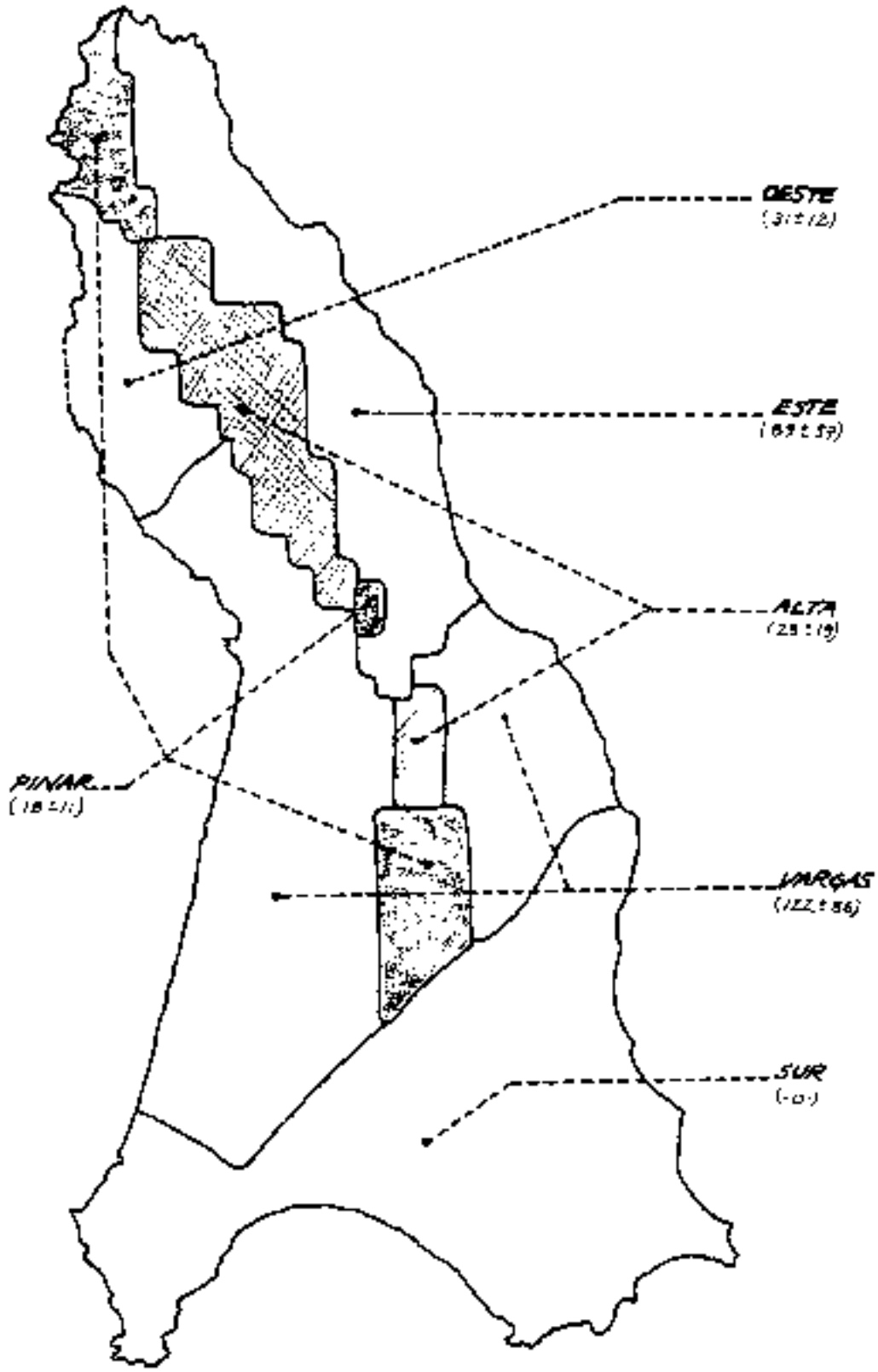
Two-sided t-tests indicated that one single measure of strip width could be used for all areas sampled ($t=0.040248$, $0.30<P<0.40$, d.f.=142, NS).

The results of residual analysis indicated also that the assumptions of normality and equal variances were approximately met. Strip width averaged 1.03 m, whereas transect length was 2 km on the average (1-4 km).

The typical short, torrential winter rainfall in Cedros washes away and scatters deer droppings once a year. Considering that the last such rainfall swept clear the slopes and drainages in mid-December, days of accumulation were calculated from December 18 to the date on which the transect was run.

The total population estimate for the entire deer range on Cedros island is 288+/-185. Estimated number of animals per physiographic region are shown in figure 12. While caution should be exercised in accepting these number given the assumptions underlying the calculations, we believe it is a reasonable estimate of the population.

Figure 12 Estimated number of animals per physiographic region


OESTE
(31 ± 12)
ESTE
(69 ± 57)
ALTA
(28 ± 19)
PINAR
(18 ± 11)
VARGAS
(122 ± 86)
SUR
(-0-)

POPULATION DYNAMICS

SEX AND AGE RATIO

The sex ratio of observed adult deer on Isla Cedros was 59:100 (13 males and 22 females). Similar sex ratios have been found elsewhere for populations where hunting is absent or insignificant relative to population size (McCullough pers.comm., Wehausen 1980). However, biases in such results often occur.

Sex segregation of males and females outside the mating season is common among ungulates (McCullough 1979). Even during the breeding season, when sexes are mixed to a large degree, the greater mobility of males may introduce a bias into sex ratios obtained in the field. A complete measure of spatial separation of sexes would require a representative sampling of both sexes throughout the year (Wehausen 1980). During the present preliminary study however, such sampling was not feasible.

REPRODUCTION

The period of rut in cervids can be inferred from the behavior and condition of the males (Severinghaus 1955). On

Cedros, bucks apparently had rubbed the velvet off their antlers by the last week of July or the first weeks of August. Antler thrashing was observed in early October. Kucera(1978) stated it is performed as a threat between bucks but also in conjunction with rubbing the forehead on vegetation where an agonistic context was not evident.

The antler thrashing-forehead rub combination is presumably closely associated with the rut. The flower stalk of Agave plants were the places where all the forehead rubbing was observed. Bucks beat and twist small torote limbs, several bushes and Agave plants with their antlers.

In the second week of October a mature buck had noticeable swelling of the neck thus presumably entering the actual breeding season. The timing of breeding is governed by the receptiveness of the doe (Swank 1958). The rut period may extend from September to November. The gestation period lasts around 7 months, 202.8+/-4.93 days on the average (range 199-212)(Barnum 1930, Bischoff 1957, Dixon 1934, Golley 1957, Robinette and Gashwiler 1950). Naturally, some departures from these dates occur as a result of individual variation. Parturition occurs from March to May, with the greater proportion of the fawns being born in April.

Productivity on Cedros may be around 1.0 fawn per adult female per year, considering that each female gives birth to a single fawn (rarely twins). Occasionally, does

have been found tending two newborn fawn (Muñoz and Arce pers. comm.).

The time of rut and parturition presented herein for the deer of Isla Cedros differs by being substantially earlier that that reported for other subspecies. The shift in time mentioned before for antler phenology seems to hold for reproductive activity as well. Kucera (1978), Swank(1958) and Truett(1972) reported a late parturition period for the desert mule deer O. h. crooki. Fawning takes place from July to August, presumably when high-quality forage is most available. On the other hand, the peak in fawn drop for O. h. hemionus as estimated by Robinette et al. (1977) is June (May to August).

MORTALITY AND LIMITING FACTORS

PREDATION

No native deer predators (large carnivores) are present on the island nor have they been reported in the literature. However, both feral dogs and cats are present on Cedros Island. Feral dogs were said to be the major causes of deer mortality in the absence of native predators (Holloway and Cowan 1978). Dogs might have first arrived with the mine workers around 1890. After the miners were gone, their abandoned dogs played their role as predators and presumably

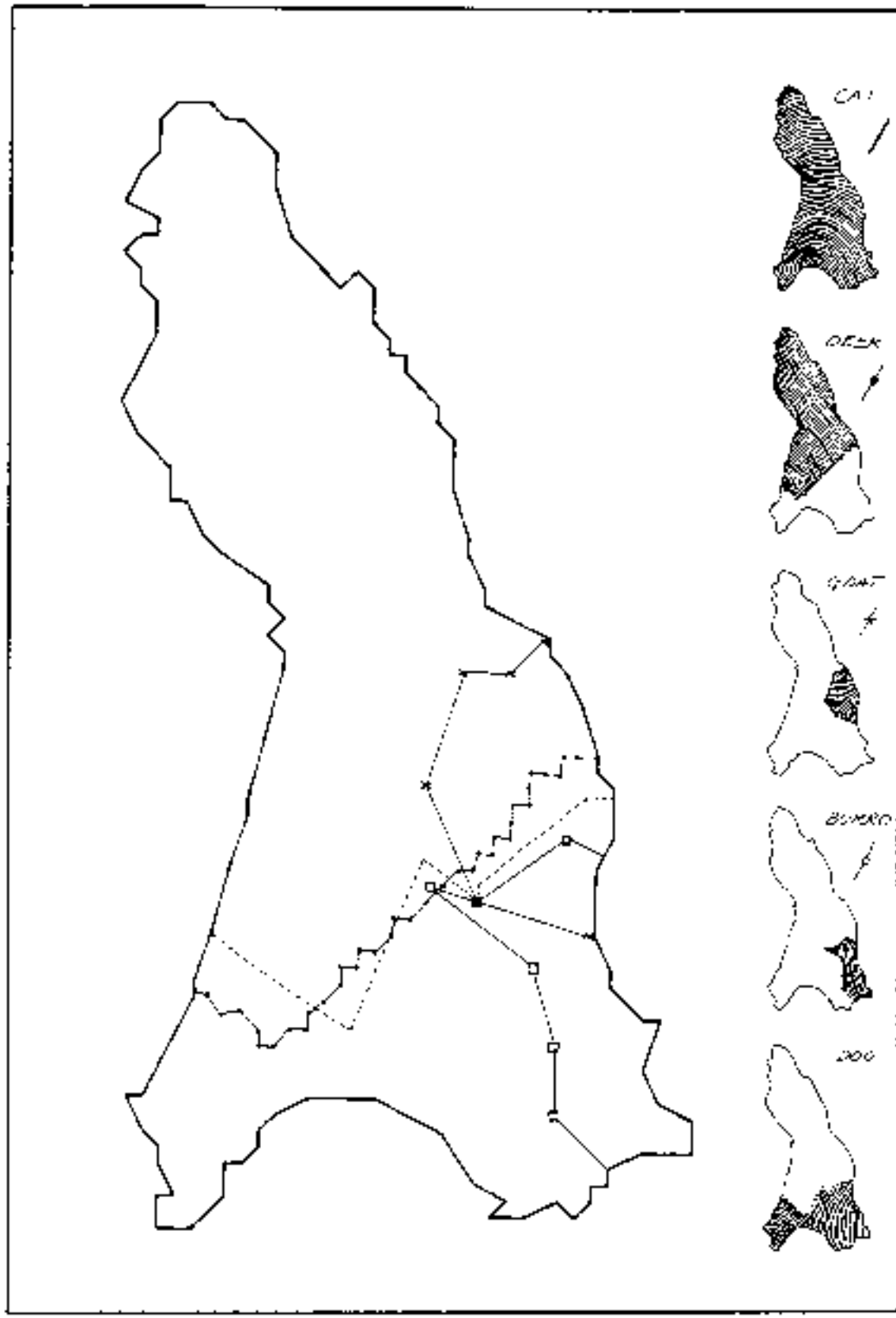
increased rapidly in number.

Some informants noted that in the late 1930's, the Mexican Navy (which was in charge of the "welfare" of introduced animals to the islands), combed the island shooting feral dogs, which had become a hazard to the introduced goats and native deer (Aguirre 1977, Bareño pers.comm.). This drastic control measure proved to be effective, Osorio-Tafall (1948) found no evidence of feral dogs during the years 1942 to 1946. At the present time, a few packs of ferocious feral dogs still wander on the southern portion of the island.

Their confinement to the south as shown in Fig. 13 barely overlaps with the distribution of deer. No deer hair was found in any of the dog scats examined (n=8). Cat, rabbit, reptile, rodent and bird remains were, however, readily recognizable. Thus, apparently feral dogs seem to be having no harmful effect upon the deer population.

By far, the most abundant mammalian species on the island is the feral cat (Felis catus) which is widely distributed throughout the island (Fig.13). Because of their relatively small size and solitary hunting habits, they present no threat to deer. Examination of 74 scats showed no evidence of deer remains.

Figure 13 Distribution of deer, and feral mammals.



POACHING

By the turn of the century, when mining was still profitable, hunting of deer was heavy (Osorio-Tafall 1948). The 1923-1928 prohibition (moratorium) on killing deer gave the population a chance to recover. Since that time, all the poaching was being done by fishermen.

Recently, however, visitors rather than local residents are responsible for the loses (Bareño pers.comm.). Alien "sport-fishing" boats that seek shelter on Cedros' east coast often take deer illegaly and with impunity (Garcia G. pers.comm.). It is also known that some are taken by temporary residents.

From the standpoint of total mortality, illegal hunting probably accounts for the death of few deer. While it is difficult to assess the actual impact of hunting, it has declined in recent years to a point that nowadays its volume can be practically neglected. Various factors may be responsible for this evident decrease in poaching.

(1) Residents of Cedros do not have the "hunting tradition" that usually maintains, spreads and enhances the desire to hunt (as in other areas on the mainland). The moves of the only two famous Venaderos (deer hunters) are well known and followed by the Mexican Wildlife Service with whom they even eventually cooperate.

(2) Deer are protected by law and the penalty for apprehension is severe. Therefore, the risk of being caught is not worth taking. Mexican Wildlife Service personnel stationed in nearby Guerrero Negro (on the mainland), constitute an ever-present law enforcement symbol.

(3) Even though travel by boat around the island is readily affordable with good weather, the rough topography of the island discourages people from climbing the rugged and inhospitable mountains to hunt, and especially to carry out carcasses.

(4) Market hunting does not exist. People are no longer dependent on wild game for red meat, but rather can afford to purchase it in the market economy.

(5) The economic boom on the island allows residents (both permanent and temporary), to go outside the island for recreation and relief from boredom.

(6) Many residents are not aware of the presence of deer on Cedros.

The somewhat relaxed condition of poaching pressure at present may not last, since human population (by immigration) and its associated pressure on wildlife is likely to increase. Both, the PPIC Cannery and ESSA plan to expand in the near future.

COMPETITION FROM FERAL HERBIVORES

Mammals have been transplanted by man as domestic stock or as pets, and have since escaped or been purposely released and then reverted to the wild to varying degrees. Considerable damage has been done by introduced mammals to the autochthonous fauna and flora of the Pacific islands. Unfortunately, this damage continues. Feral herbivores represent a threat to Cedros deer when they cause unfavorable habitat change, supplant deer on their range, compete with them for water and food resources, or transmit pathogens to them (Povilitis 1978).

Feral goats and feral burros are present on Isla Cedros, but are almost entirely restricted to the southeastern portion of the island (Fig.13). At one time burros were set free to roam at large on the island. As newly introduced species they first multiplied rapidly. As other exotics elsewhere, the species apparently changed its habits in this new environment, with serious consequences for existing communities and for man. They became a serious pest on Cedros' southern portion. House trash deposits and trash piles were common feeding sites. During the past two decades, many residents shot burros. Packs of feral dogs attacking asses and/or offspring have been observed by the villages road (Castro and Mayoral pers.comm.).

According to Salas (1979) the total burro population

estimate for the island is around 200 to 300 individuals. Assos are and have always been restricted to the lowlands by the villages. Our estimate, on the contrary, is less than 100 individuals. At the present time, there is no overlap in the distribution of deer and burros on the island.

The distribution of feral goat, on the other hand, seems to be increasing gradually (Salas 1979). Among the feral herbivores, feral goats in particular may be singled out as exceedingly detrimental; they have been instrumental in the virtual annihilation of vegetation and the consequent disappearance of many native forms on several islands. They travel over all types of terrain and consume all kinds of browse and herbaceous material.

On Guadalupe island, goats were first released by Russian whalers in the eighteenth century. Heavy browsing destroyed the vegetation, followed by erosion of the soil. In contrast with what has happened in several oceanic and continental islands (Guadalupe as an example), feral goats in Cedros have not depleted the island nor flourished here.

The result of an introduction is unpredictable; both relative success and amount of disturbance depend upon the newcomer as well as upon the composition of the invaded community. Whether the presence of the deer on Isla Cedros has indeed buffered the rapid increase of goats is at this point mere speculation.

Povilitis (1978) stated that other ungulates are inclined to relocate when faced with the unsettling presence

of domestic (feral) stock. No evidence of such a spatial displacement was recorded during this study, on the few slopes, ridges, and ravines where goats and deer are sympatric.

Distinguishable fresh tracks and pellet-groups of both species were found. Sign of browse left on plants were of similar appearance. An adult male goat was observed feeding upon eight different plant species; all of these were recorded as forage species of the deer as well. Plants eaten include the following species: Arctostaphylos bicolor, Ephedra aspera, Galvesia juncea, Pachycormus discolor, Penstemon cerrosiana, Perityle emoryi, Simmondsia chinensis, and Xylococcus bicolor. Thus, potential competition between deer and goats could develop if the goats spread into the deer range in the future.

The distribution of feral dogs, goats and burros are compared with that of the deer in figure 13. The range of the deer lies within the range of the feral cats which occupy the entire island.

DISEASES AND PARASITES

Rarely, diseases and parasites constitute major causes of mortality. Most striking exceptions being the epizootic die-offs. However, parasites and disease organisms that

are found sparingly in the healthy deer, may increase to the point where they become a lethal factor.

When they begin to cause mortality, the actual cause can be usually traced back to either insufficient food or food of poor quality. As the nutritional intake declines, the animal's resistence goes down .

A consequence of animal introductions generally not fully appreciated is the importation of diseases and parasites of which the exotics are hosts. There is evidence that parasites and diseases of introduced mammals are at least partly transferred with their hosts to the new biota.

Most diseases are more dangerous to a previously unexposed population, since no immunities have been developed. Introduced diseases may easily become established in native species, and may prove impossible to eradicate.

There is a danger of disease and parasite transmission to the Cedros deer from feral goats and feral burros or by fecal contamination of the environment by dogs and cats. What the outcome of such potential transmissions might be is impossible to foresee. Further studies are needed to evaluate the actual importance of this two factors on the population of deer on Cedros. Various authors have listed both, parasites and diseases recorded from mule deer elsewhere (Cowan 1946, Linsdale and Tomich 1956, Robinette et al.1977, Swank 1968 and Taylor 1956).

WATER

Mammals which inhabit the desert regions of the world are exposed to two major interrelated physiological problems: the maintenance of an adequate water balance and the maintenance of a suitable temperature range. The higher temperatures typical of the deserts often present the problem of an additional water requirement for temperature regulation.

A number of different solutions to the problem of maintaining water balance in arid environments are used by desert mammals. Water can be obtained by drinking water, free water in food or by oxidation of fat's hydrogen (metabolic water). Availability of free water and the amount of water in the air affect the habitat and microhabitat selection of mammals (Vaughan 1972).

Water requirements for Cedros Island deer should be less than those of the desert mule deer due to the milder environmental conditions relative to those of the Arizona desert, and to the relatively higher humidity on Cedros. Highly succulent vegetation could relieve the necessity to drink, but free water is, nevertheless, still required by deer during the heat of the summer. Superficial running water is available at higher elevations almost throughout

the island. In June-October we observed springs and arroyos to carry little water.

The only exceptions being the springs of Monte Cedros of a rather surprising freshness (the water of one of which is pumped to the Cannery's village). During the present study, only in a few drainages water kept running all the way down to the shore.

Deer on the island are capable of attaining their moisture requirement from plants in their diet and by drinking free "salty-bitter" water. Cedros water is high in minerals, having a more or less pronounced salty and bitter taste, yet potable (drinkable after getting used to it).

Tiny ponds are formed here and there and depending on the degree of stagnation, water bears animal and plant life (algae, dragonflies, tadpoles, etc.), or becomes turbid, changes colors (gray, pink, green, ochre, yellow etc.), and precipitates minerals. Dried river-beds have a coat of salts of varying thickness (2-15mm).

Pine forested areas have no superficial water; however, these groves are the parts of the island most consistently enveloped by fog and clouds, and the condensation and dripping of moisture from the needles is thought to be the major water source for the pines, exceeding the rainfall (Moran and Benedict pers.comm.).

Although the absence of deer from the southern part of the island may be partly a result of the lack of surface

water on that region, water availability seem not to constitute such a critical constraint to the deer population on most of Cedros Island.

It is our impression that if water remained available during the months of this study, it is probably available all year round.

STATUS AND PROGNOSIS FOR SURVIVAL

Following IUCN's categories, Cedros deer should be considered as a Vulnerable subspecies, likely to move into the endangered category (IUCN 1976). Deer might not be under immediate threat of extinction but since they have been seriously depleted, their ultimate security is not yet assured.

To say that the subspecies may be recovering can be based on the considerations listed below and previously explained herein.

i) there is virtually no environmental impact.

ii) hunting is low.

iii) no predators are present on the island.

iv) sex ratio and behavior recorded resemble that of an undisturbed population.

v) no drastic changes in climatic factors have occurred at least in the past 20 years (as can be deduced from the records), and

vi) The Mexican Wildlife Service (D.G.Fauna

Silvestre) estimated a total population of 159+/-35 individuals for 1978, while our estimate for 1980 is 288+/-185 deer.

Even though the population of deer on Cedros might well be recovering, hence increasing, a larger population size will not necessarily make the future of the subspecies any more secure, even if deer are below an as yet unknown carrying capacity. There is no safety in large numbers, especially where populations are confined to insular situations, with no chance for repopulation from nearby areas in the event a natural or man-made disaster occurs.

According to Cowan and Holloway (1973) assessment of trends in population may be a projection, largely dependent on:

i) the degree of security that a species is afforded by legislation and by the size and nature of its range, and

ii) on the degree of pressure to which it is subjected.

Therefore, if and only if the legal provisions against poaching, destruction of the habitat and other detrimental factors do not remain merely on paper, can the prognosis for survival of the subspecies be referred to as promising.

Deer population could undoubtedly be increased by one or more of several methods, but since the herd is at present unharvested, it would be unsound economically to instigate intensive management practices now.

A logical recommendation to reduce the vulnerability to extinction of a species or subspecies is to establish populations in different locations, since loss of any given population can be compensated for by the others. The former recommendation however, may not find applicability for the case of the deer on Cedros or any endemic island population. These deer require careful "in-situ" attention instead.

We regret to admit that one factor that has unquestionably contributed to the survival of the deer on Cedros is the nescience of residents about this creature. Instead, pride for and knowledge of the deer by islanders should, ideally, constitute the guarantee to the welfare and survival of their deer. Many human residents of Cedros have a respect and appreciation for their natural resources not found among off-islanders. This condition makes proud islanders the best qualified possible choice, if guards for the island's resources were to be hired.

Many residents of Isla Cedros are aware of the need for conservation. Fishing and trapping seasons are enforced locally, both by officials and by the fishermen themselves. Mexican Fisheries Department officials stationed on the island issue the appropiate permits and keep track of the utilization (extraction) of marine resources. It is fair to say that fishermen clearly understand the rationale behind the prohibitions and regulations. They explained their

shift in activities as a need to ensure long-term availability of resources.

Often, one of the first steps in running a protection programme for a species is to raise consciousness of local inhabitants around the issue. In Cedros, owing to the residents relative familiarity with prohibitions, regulations and seasons, their receptiveness could be expected to be one step forward.

Up-to-date materials on the island, the deer and on broad issues of nature conservation should be prepared for dissemination in public relations programmes. A campaign to spread widely the idea of protecting deer and deer habitat as a whole is very desirable. Besides that, people want to know more about their deer and officials and enterprises are more than willing to cooperate. Parenthetically, such an activity could aid in the promotion of wider interest and understanding of nature and nature conservation.

International funding should be taken as a trigger in promotion of national awareness and involvement in conservation. As correctly stated by Cowan and Holloway (1973), if threatened deer populations are to be conserved in their natural environment in perpetuity, management of the species must be administered and financed by the countries in which they occur. International funding is inadequate to sustain individual projects indefinitely.

Cedros island deer seem to be another example of a almost forgotten species (subspecies in this context), as a result of apathy at certain administrative levels. What is needed is a sustained financial commitment on the part of Direccion General de Fauna Silvestre and perhaps other national organizations.

The deer is in aesthetical, recreational, educational and scientific terms unquestionably adding value to Cedros patrimony. Isla de Cedros is a unique place, with a great variety of unparalleled features and conditions, a challenging, rewarding, interesting and attractive location. Cedros should remain undisturbed, as a strict natural or wilderness area. Consideration might be given to the creation of a wildlife reserve that would help secure the entire area and protect all species which live there. On paper, Cedros Island's coastline was declared a "Sanctuary for Pinnipeds", but lacks of proper enforcement.

The introduction of mammals is definitively a hazardous undertaking and further introductions should be forbidden. The impact of introductions needs to be carefully considered in advance, otherwise Cedros, as might any other island, may follow the disastrous example of Guadalupe Island. Increasing diversity by means of introduction of exotics is a mirage or perhaps simply a vulgar fallacy.

Management practices used for a wildlife species should be compatible with other important land uses, and conversely

exploitation of any resource on Cedros should not overlook the value and needs of the living resources. Environmental impact assessments are required before initiation of new actions.

Mexico has an extremely rich and varied natural fauna heritage, but one that is rapidly disappearing. I need not mention how depressingly long is Mexico's list of threatened wildlife. Sophisticated and/or complex (the so-called "in depth") studies are not required to detect problems.

I strongly believe that well thought out action is in order, for there is still too much to do, and relatively to little being done.

I hope this modest contribution will not only succeed in its own aims of preventing this subspecies of cervid from sinking, but also in promoting the growing conservation cause to safeguard other species of Mexico's native fauna and flora.

SUMMARY

The Cedros Island deer, referred to mule deer as Odocoileus hemionus cerrosensis Merriam 1898, constitutes an endemic subspecies in its own right, whose type locality and range is Cedros Island. They are, on average, smaller in size and lighter in weight than the mainland races (body length 1600 mm, shoulder height 900 mm, weight 80 kg). Cranial and antler measurements are also smaller than those of the mainland subspecies. No brow-tine is present. They have an overall paler pelage, with no white hair and marked with a distinctive dorsal dark-brown line extending from the neck, back to the rump and down the dorsal surface of the tail. The tail shows a unique coloration pattern.

Track length and width measurements were 60X50 mm for males and 50x40 mm for females. All characteristics displayed by this race however, fall within the broad range of clinal variation of Odocoileus hemionus. Because of their long separation from the mainland, Cedros Island deer probably represent a well-defined genetic population.

Distribution of deer on the island was determined by combing by foot the entire extension of the island. Deer range comprises an area of 23,400 hectares (i.e.aprox.65% of the total area of Isla Cedros). The population seems to be evenly distributed throughout its suitable range, which

includes all but the southern portion of the island. The total population estimate derived from 224 pellet-group counts was 288+/-185 individuals (aprox.0.012 deer per suitable ha). Minimal number of animals observed was 42 individuals (13 males, 22 females, and 7 fawn), with an adult sex ratio of 59:100 and age ratio of 32:100 females.

The rut period may extend from September to November. Swelling of the neck was noticeable in October. Fawn drop occurs from March to May with the greater proportion of fawns being born in April. Productivity may be around 1.0 fawn per adult female. Time of rut and parturition for the deer of Cedros Island is substantially earlier than that reported for other subspecies.

The reaction of deer to the observers suggest that 76.19% of the animals were to varying extents tolerant to the odour and sight of humans. Encounters with deer during all four months took place more frequently between 11:00 and 15:00 hours. However, activity records for August suggest that deer are more active between 06:00 to 07:00, 18:00 to 19:00 and 23:00 to 24:00 hours. Feeding, antler thrashing, grooming, forehead rubbing, traveling, and bedding were among the activities recorded during those time intervals.

The most important plant species relative to deer are as follows: Eriogomun molle, Eriogonum pondii, Pentstemon cerrosiana, Galvesia juncea, are exclusively forage species. Pachycormus discolor, Simmondsia chinensis, Rhus lentii,

Rhus integrifolia, Arctostaphylos bicolor, Xilococcus bicolor, Acalipha californica, Tamarix pentandra, provide both food and shelter (bed and escape cover). Agave schawii var sebastiana, Juniperus californica, Quercus cedrosensis, Pinus muricata var cedrosensis and Senecio cedrosensis are used for shelter, antler and forehead rubbing, scrapping, etc. No marked preferences for any slope aspect or topography was evident during the study period. Water remained scarce but available through October, just before the rainy season begins. Clouds and fog from the west play an important role in water supply.

There are no native predators on the island, and no evidence of mortality attributable to the few feral dogs was found. The ranges of feral dogs and deer hardly overlap. The feral cats are widespread, but have no direct effect upon deer. Poaching is of less importance as a source of mortality than in the past. The deer are totally protected, although the law is difficult to enforce. Main offenders are off-islanders (foreign "sports fishermen"), whose actual effect, although undetermined, appears to be very low.

There was no indication that mortality from diseases nor parasites occurred during the study.

Feral burros and goats are, if not actual at least potential competitors of deer for food and space. At present, the distribution of deer and feral stock, either do not overlap (burros) or overlap only slightly (goats).

Cedros deer should be considered as a Vulnerable subspecies, likely to move into the endangered category (IUCN 1976). Deer might not be under immediate threat of extinction but since they have been seriously depleted, their ultimate security is not yet assured. Cedros Island deer could quickly disappear and therefore requires careful watching.

If and only if the legal provisions against poaching, destruction of the habitat and other detrimental factors do not remain merely on paper, but are enforced, can the future of the subspecies be promising.

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