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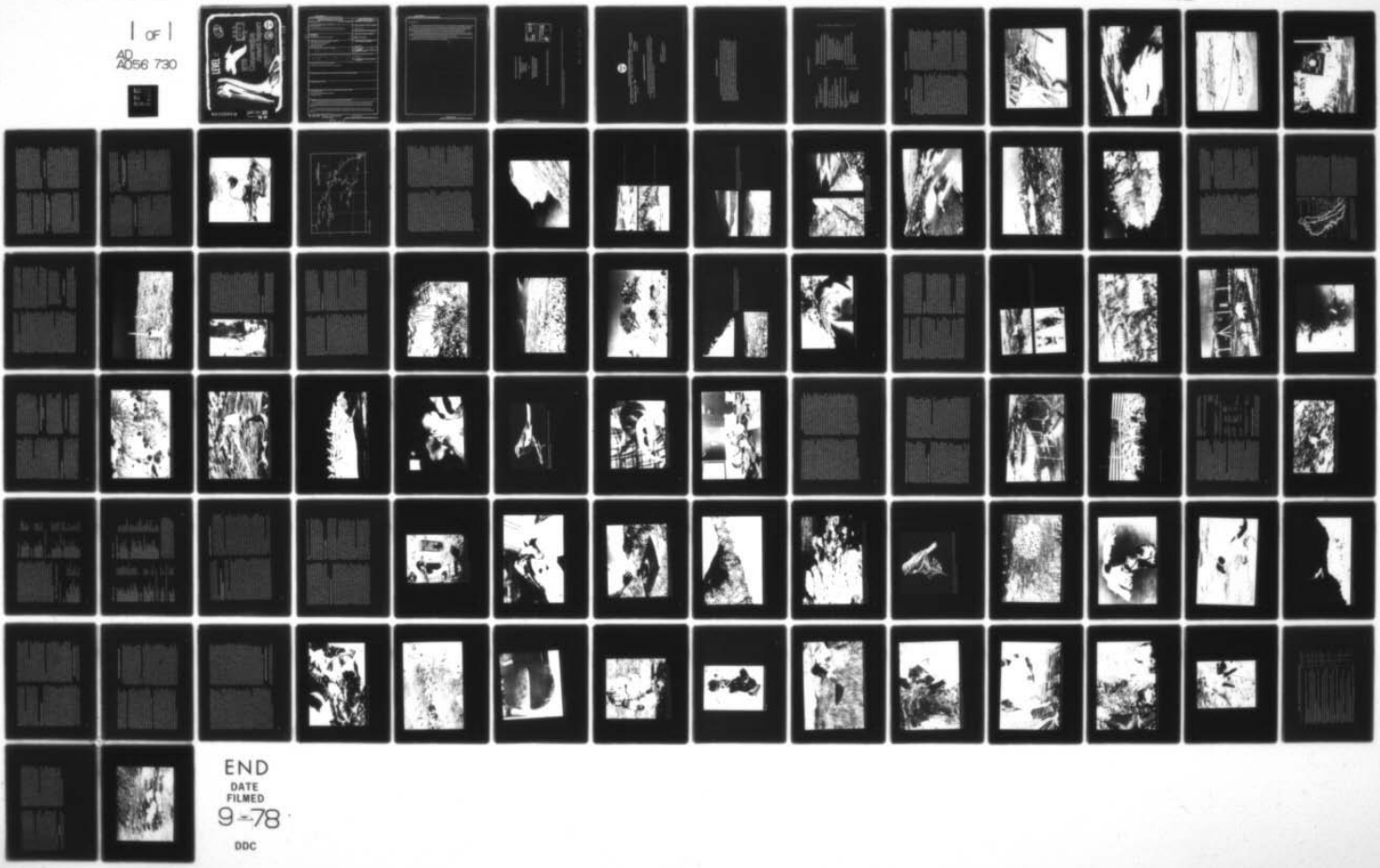

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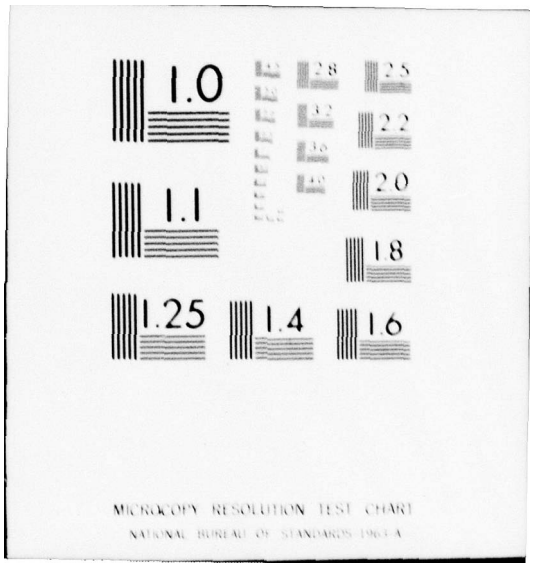
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# 1978 Conservation Award Report



TD-150

Naval Ocean Systems Center San Diego, CA 92152

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This report summarizes the natural resources conservation efforts, on the part of the Naval Ocean Systems Center, performed during 1975-1977. These efforts were particularly concerned with the federally declared endangered and threatened species and those species that may potentially be so considered in the foreseeable future.

The report also describes the military mission on the island, the extensive natural resources, and the physical and cultural resources which also fall within the management efforts of the Natural Resources Program Office.

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These resources are administered under the jurisdiction of the Natural Resources Management Committee. The committee is comprised of members of the Natural Resources Program Office, federal and state wildlife and conservation agency representatives, members of the academic community, as well as representatives of NOSC's military and research personnel. The committee is chaired by the Public Works Officer.

The Natural Resources Program Office administers the island's natural, physical, and cultural resources through the Natural Resources Management Plan and cooperates with members of the academic and scientific communities interested in performing unique and meaningful research on the island.

Evaluating the results of the conservation efforts on the island would be premature at this time, although indications for recovery of the biotic environment seem promising.

NOSC Technical Document 150

# 1978 Conservation Award Report

28 March 1978

Prepared by
Peter Kasaty

for

Natural Resources Program Office
Naval Ocean Systems Center
San Diego, California 92152



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Cover: An island resident, the brown pelican's population status is of concern to environmentalists. The species nearly became extinct in the 1960's and there is evidence that it is still not out of danger.

NAVAL OCEAN SYSTEMS CENTER, SAN DIEGO, CA 92152

AN ACTIVITY OF THE NAVAL MATERIAL COMMAND

RR GAVAZZI, CAPT, USN
Commander

HL BLOOD
Technical Director

## ADMINISTRATIVE INFORMATION

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Released by
JB Kasner, LCDR USN, Head
Public Works Department

## ACKNOWLEDGEMENTS

The author gratefully acknowledges the invaluable contributions made by the field researchers and the authors of the many scientific articles whose work was so extensively referred to in the preparation of this report. In particular, the work of Roger Burger, Robert Cohen, Robert Morrow, Larry Sward, and Roger Wilson, as researchers for the Natural Resources Program, collectively, has been a great asset to the ongoing management programs. The support of the NOSC Public Works staff and LCDR Jon B. Kasner, PW Officer, is also gratefully acknowledged. Finally, I would like to express my heartfelt thanks to Jan K. Larson, Natural Resources Program Wildlife Biologist, for the unswerving support and the extensive constructive criticism. Needless to say, any errors which may be present are the author's own.

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# INTRODUCTION

## NAVAL OCEAN SYSTEMS CENTER

The Naval Ocean Systems Center (NOSC) was established in March, 1977 through the merger of the Naval Electronics Laboratory Center (NELC), and the Naval Undersea Center (NUC). The Center is located on Point Loma, San Diego, California and operates under the direction of the Naval Material Command.

NOSC is a full-spectrum Center, from planning and intelligence inputs through the command control and decision-making process via communications, to the ultimate response in terms of weapons and electronic warfare. The mission of NOSC is that of being the principal Navy research, development, test and evaluation (RDT&E) center for command control, communications, ocean surveillance, surface and air-launched undersea weapon systems, and the supporting technologies. Major areas of RDT&E work include command control and communications, electronic warfare, undersea surveillance, antisubmarine warfare weapons systems, ocean science, ocean engineering, biosystems research and related technologies. NOSC also pursues an extensive in-house and Navy program of systems analysis and evaluation to provide support for in-service systems and direct assistance to the Fleet. The Center employs approximately 2,600 full-time permanent and temporary employees and has a military allowance of approximately 360 officers and enlisted personnel. In addition to the Center's primary facilities located at San Diego, California, other facilities are located at various sites in the northern half of the western hemisphere. One of the more important of these outlying facilities engaged in RDT&E programs is located on San Clemente Island.

## SAN CLEMENTE ISLAND

The Navy's administration of San Clemente Island began in 1934. Previous to that time the island had been administered by the Department of Commerce and was leased for sheep ranching. The Navy first used the island primarily for the development of Fleet training facilities, which remains an aspect of its use to the present day. An airfield and a cantonment area were constructed during World War II, and the shore bombardment area at the south end of the island was also established at this time. Beginning about 1950, the island was used extensively for shore and underwater rocket and missile research, development, and testing. In addition, torpedoes and depth charges were tested in shallow water areas surrounding the island.

A U. S. Air Force radar station was in service on San Clemente Island from 1951 through 1961. In the same year that the radar station was deactivated, a new airfield was constructed at the north end of the island and the World War II facilities were abandoned. Fleet training, ordnance disposal and storage, and missile testing continued through the 1960's and early 70's. The administration of the island has periodically changed through the years – within the Navy – with the most recent transfer occurring in October, 1977. (To the Naval Air Station, North Island, San Diego, California.)

The Navy's current utilization of San Clemente Island is similar to that of the past and may be best discussed in terms of two primary areas. The first area is that of research, development, testing, and evaluation. NOSC utilizes the island extensively for RDT&E, along with other government agencies and private companies under government contract. The island and the surrounding waters are equipped with

Figure 1. In the foreground, NOSC's bayside research laboratories and pier facilities. (Some of San Diego's extensive recreational facilities may be seen in the background.)

Figure 2. The Southern California coastline as seen by satellite. San Clemente Island is in the left foreground, and Santa Catalina Island is between it and the mainland.

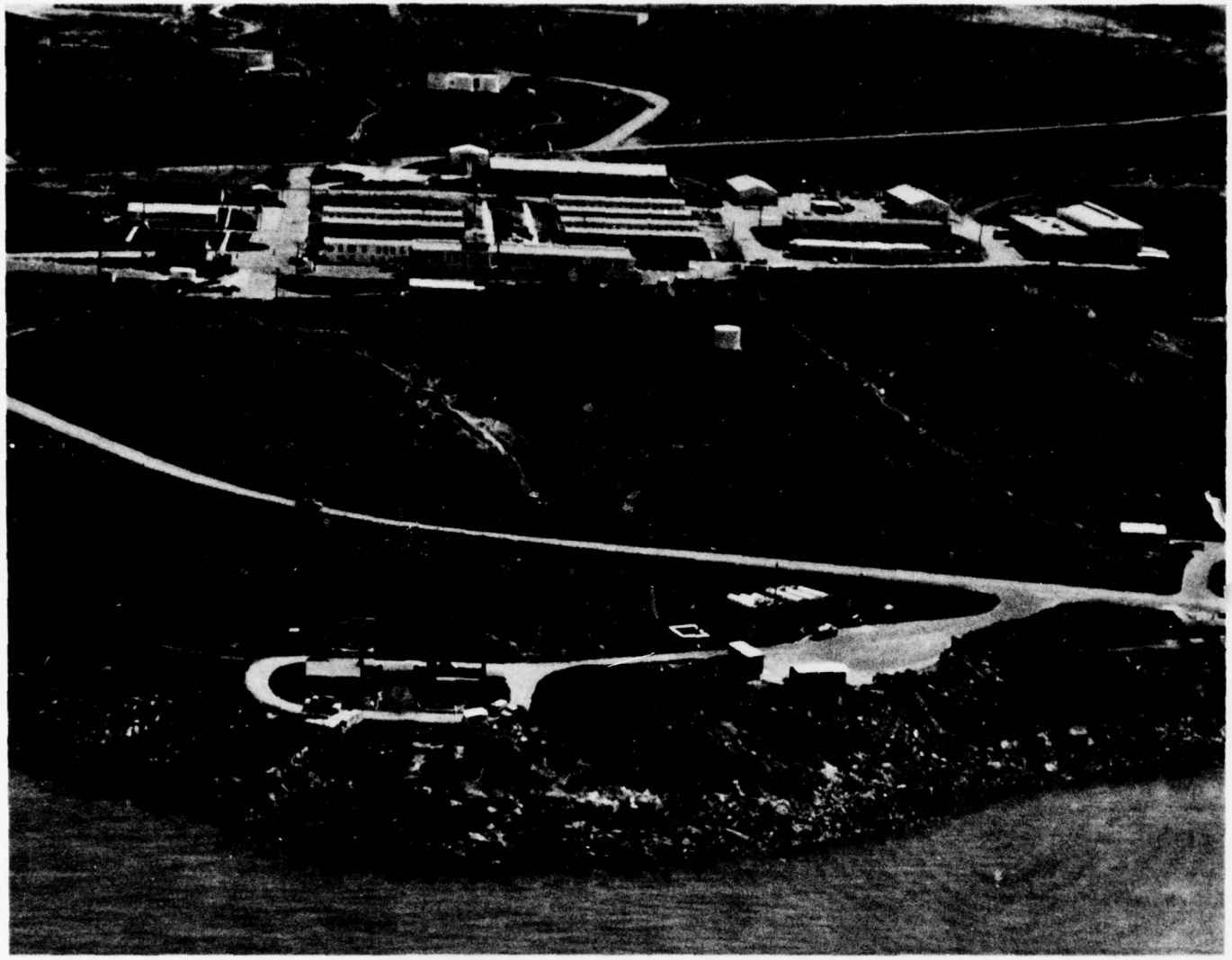

Figure 3. The barracks and headquarters area at Wilson Cove, San Clemente Island. Along with adjoining facilities, this area comprises the major military development on the island.


Figure 4. On an otherwise barren roadside, four Eucalyptus trees have been "honored" by island personnel.

special and general purpose test and sea range facilities, instrumentation, and communications. The second major user area is occupied by Fleet organizations and other tenants. Services and gunfire support are provided to other Navy organizations, including Fleet units on training exercises. Tenant activities are as diverse as they are numerous. Of a total population of approximately 500 individuals, 25 are officers, 200 are enlisted personnel, 175 are civilians, and 100 are in transient status.

With the increasing limitations placed on the activities of the Navy at its mainland bases, San Clemente Island will continue to see heavy military utilization of its facilities in the foreseeable future. The island's remoteness is probably its chief asset, for security and safety reasons as well as insurance of an extensive buffer zone from civilian population centers.

## CONSERVATION OBJECTIVES ARE COMPATIBLE WITH THE MILITARY MISSION

The natural beauty that surrounds us and the cultural treasures of the past are obviously quite important to us all. They are so important that we have, through our legislators, enacted laws to ensure their survival in order that they may be a joy and an inspiration for generations to come. In striving to attain these goals, the Federal government has created a national park system, wilderness areas, and historic monuments. (State and local governments have also taken similar actions.) The Endangered Species Act and Executive Order 11593, "Protection and Enhancement of the Cultural Environment," are two of the most important of the Federal pronouncements.

Mandated conservation efforts are particularly compatible with the military mission on San Clemente Island. Many of the Navy's activities on the island require large safety zones, or "buffers." The physical facilities themselves require only a small portion of the island's land area. These safety zones extend out to sea and incorporate significant portions of the island's land area for activities as diverse as ordnance storage, missile testing, and shore battery firing. The isolation that makes San Clemente Island ideally suited for the Navy's activities also requires that almost every other activity imaginable, including public access for recreation, be completely excluded. However, this doesn't exclude the conservation effort on the island, and, in fact, the two have similar needs. Each activity requires maximum isolation and a minimum of human activity. Thus the conservation effort makes use of almost the entire island while at the same time not interfering with the military mission.

## ISLANDS ARE UNIQUE . . .

The Latin word for island is insula and the word itself breathes the spirit of island life. Here, surrounded on all sides by a huge protective moat, life evolves in a manner quite different from that of continents – insulated from so many factors that significantly affect the development and interrelationships of life forms. Darwin's work on the Galapagos Islands pointed out some interesting facts while developing more significant arguments concerning the evolution of species. First of all, he noted that many species of plants and animals that occur on the mainland were not to be found on the islands; that is, the biotic community was a depauperate one. This is due, in part, to the fact that many organisms do not possess the ability to emigrate over large expanses of water. Secondly, those species of plants and animals that were found on the islands evolved as a unit into new and different species over a very long period of time in a process called adaptive radiation. With the lack of competition and

the lack of predators which were restrictive factors on the mainland, many new forms were able to develop.

And so, in a sense, islands are "holiday resorts" for the biotic communities which populate them, and allow development in many new and unique ways not possible in mainland environments. For example, island species of moths are often quite colorful. On the mainland, this trait doesn't occur since there are numerous predators which would exploit nonprotective color patterns. Other species of insects, having colonized islands, may lose their ability to fly in the absence of the mainland predators. Islands promote the evolution of uniqueness, but at the same time increase vulnerability.

## BUT THEY'RE ALSO FRAGILE

With man's discovery and exploitation of islands came his disruption – albeit often unwitting and unintentional. Those very traits which make islands so unique – the relatively small land mass, the limited size of the various biotic populations in equally limited and fragile habitats, and the vulnerability of those populations to outside pressures, ie, introduced predators – also leave the native ecosystem, quite tragically, prone to man's interference.

New Zealand, probably more clearly than any other archipelago, dramatically shows the impact of man's meddling. Rabbits, sheep, goats, and deer were released at various times on many of New Zealand's islands, and, subsequently, much of the native flora and fauna has been destroyed. Plant communities that have developed without the need for protection against grazing animals are quite vulnerable when exposed to introduced animals. Along with the destruction of plant communities came the demise of animal species, particularly birds, since plant communities serve as feeding and nesting habitats. The relationship between uniqueness and vulnerability was all too dramatically shown. What took thousands of years to create was destroyed in less than two centuries.

The havoc wrought upon New Zealand's plants and wildlife by aggressive alien species is but one episode in a worldwide pattern.

## DESCRIPTION AND NATURAL HISTORY OF SAN CLEMENTE ISLAND

When approached by air San Clemente Island seems to have a stark and barren landscape; when viewed from the sea the island presents a steep scarp along the eastern shoreline, rising to about 460 meters (1500 feet). These cliffs, covered by loose rubble and prickly pear cactus, caution the adventurous spirit and give rise to foreboding feelings. Both impressions are equally misleading for San Clemente Island is much more. The initial introduction sets up barriers that, for those that would persist, yield to a unique richness. The perceptive are never disappointed.

San Clemente Island is the southernmost of the eight Channel Islands located off the coast of southern California (refer to location map, figure 6). The island lies south-southwest of San Pedro, the nearest mainland point, and west-northwest of San Diego. The nearest land, Santa Catalina Island, is interposed between San Clemente Island and the mainland. The island is long (34 km; 21 mi) in proportion to its width and its longer axis has a northwest-southeast trend, approximately parallel to the shore of the mainland. The southeast third of the island has a breadth of 6.5 km (4 mi), while the remaining two-thirds tapers towards its northwestern end, where it is only 1.6 km (1 mi) across. The island's land area is 148 sq km (56 sq mi), which makes it one of the larger Channel Islands.

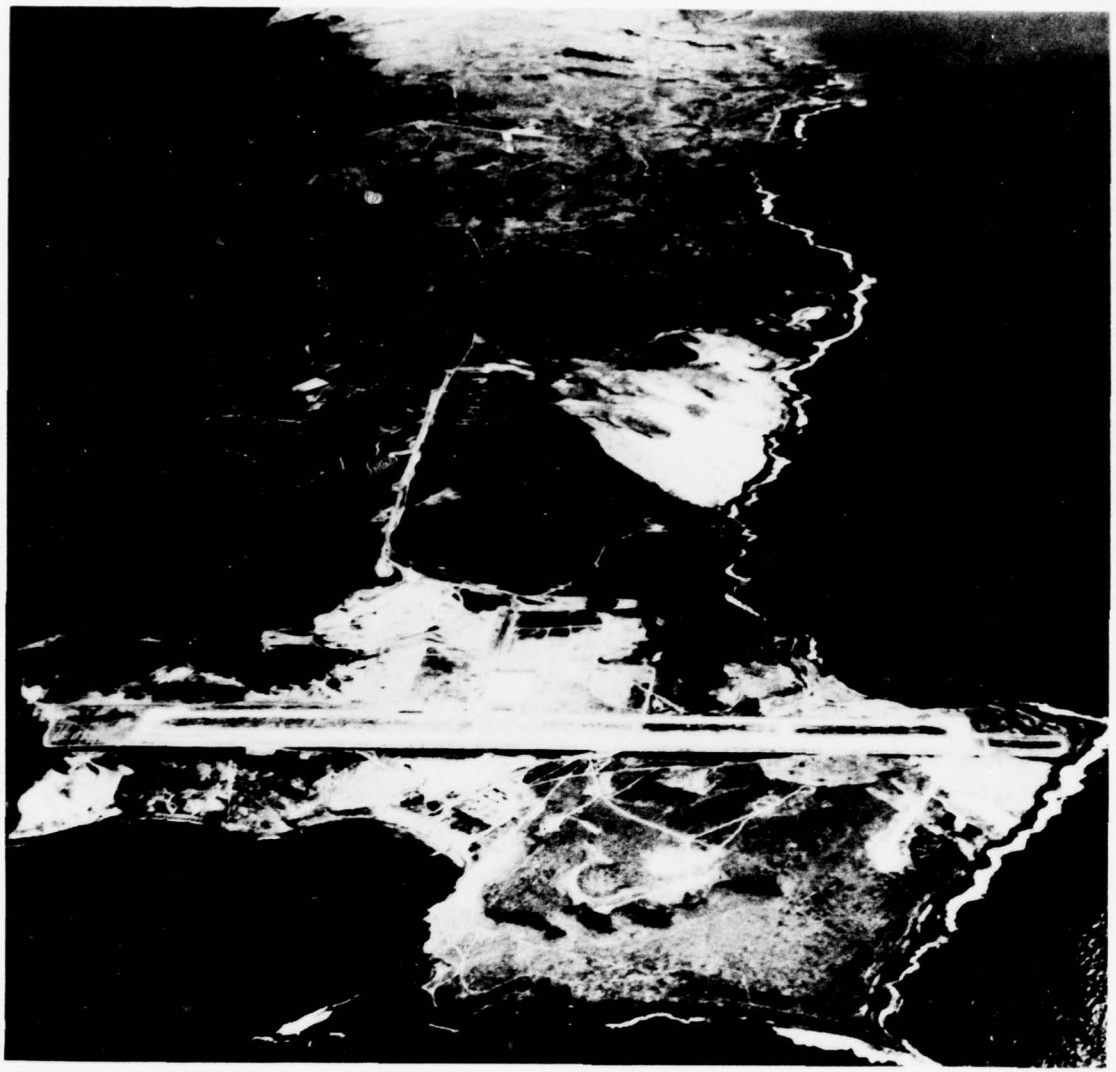

Figure 5. San Clemente Island, looking southeast, as viewed by air. The Auxiliary Landing Field is in the foreground. The Wilson Cove complex is on the left, across the island from the light-colored sand dune area.

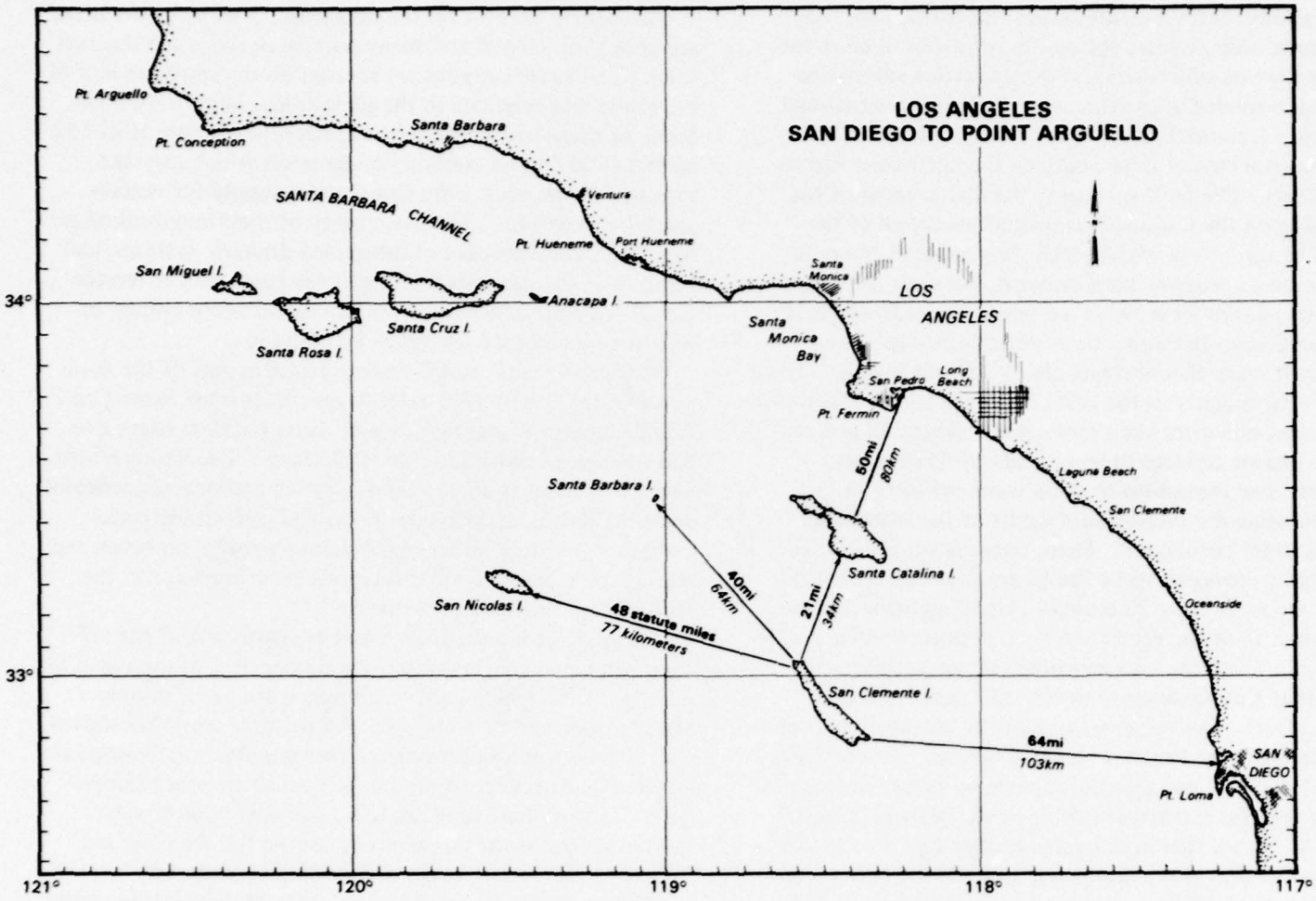


Figure 6. Location map.

Geologically, San Clemente Island was formed approximately three million years ago and may be described as the emergent portion of a tilted and gently arched submarine ridge. It is bounded approximately a mile to the northeast by the San Clemente Fault which parallels the island and extends several tens of miles, both to the northwest and to the southeast. The fault is roughly parallel to most of the major faults on the California mainland northeast of the island. The top of the island block rises more than a mile above the ocean floor to the northeast, but only the upper 600 meters (2,000 ft) is above sea level. The side adjacent to the San Clemente Fault, the northeastern slope, is an eroded fault scarp that averages about 15° but locally is more than 30°, particularly in the cliffs above sea level. The southwestern side, however, has a more gentle slope and is dominated by marine terraces to an altitude of 457 meters (1,500 ft). The formation of these wave-cut terraces occurred during the intermittent uplift of the island and the continental borderland. These terraces are some of the most striking examples to be found anywhere in the world.

There are more than 20 terraces extending from near sea level to the top of the island and they indicate former stands of sea level. There are also an additional seven submarine terraces that extend down to nearly 180 meters (600 ft) below sea level. The terraces slope gently seaward, as does the similar offshore bench now being formed. The surfaces are mantled thinly and discontinuously by gravel and sand of marine origin, by gravel and rubble of alluvial and colluvial origin, and by soil that is characteristically high in clay content. The terraces also contain evidence for the periods of the island's partial submergence. A study is in progress in which their respective dates of formation will be determined and which should add significantly to the knowledge of the island and the geochronology of the southern California region in general.

The marine terraces on the northeastern slope of the island are poorly developed and many narrow canyons cut through them. The larger canyons are located on the southern half of the island and originate in the plateau-like upper elevations. Some of these larger canyons reach depths of more than 150 meters (500 ft) and contain plunge pools which may last throughout the year, affording a water supply for various animal populations. The irregularity of their longitudinal profiles, the virtual absence of integrated drainage systems, and the lack of the canyons existing at the basal marine terrace are all evidence of the youth of the island's topography as well as of its recent emergence from the sea.

Stratigraphically, San Clemente Island is part of the compound ridge system that extends southeast from Santa Cruz Island through Santa Barbara and Santa Catalina Islands to San Clemente Island and Fortymile Bank. The island is ordinarily described as consisting of a rather uniform sequence of andesite, dacite, and rhyolite flows and pyroclastic rocks overlain by middle Miocene sedimentary rocks; however, the stratigraphic and structural relations are complex, and the sedimentary environments diverse.

Overlying or interbedded with the upper part of the volcanic sequence are thin, discontinuous masses of marine sedimentary rocks which contain abundant fossils of middle Miocene through Pliocene age. Recent field work has shown that at least four discrete chronostratigraphic subdivisions are apparent in this depositional sequence. Quarternary slopewash detritus, dune sand, and fossiliferous shallow-water marine sediments unconformably overlie the Miocene and Pliocene sedimentary rocks at nearly every outcrop.

Interest in San Clemente Island paleontology began in the late nineteenth century. Although tons of fossils have been removed from the island since that time, very few reports of scientific merit have been published. In one of the more recent studies, fossil teeth approximately ten cm (4 in) long

Figure 7. The island's eastern scarp. Loose rubble makes it more hazardous than one would think possible.

Figure 8a. The western shoreline. A striking contrast to the eastern side.

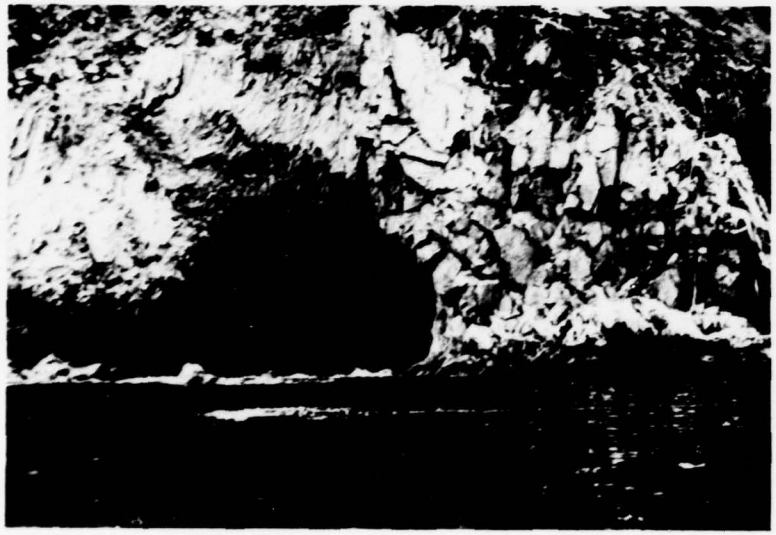

Figure 8b. One of the many picturesque sea caves on the western shore.

Figure 9. The marine terraces. Formed by wave action during the island's slow emergence, more than twenty distinct levels are to be found and are also the object of scientific research.

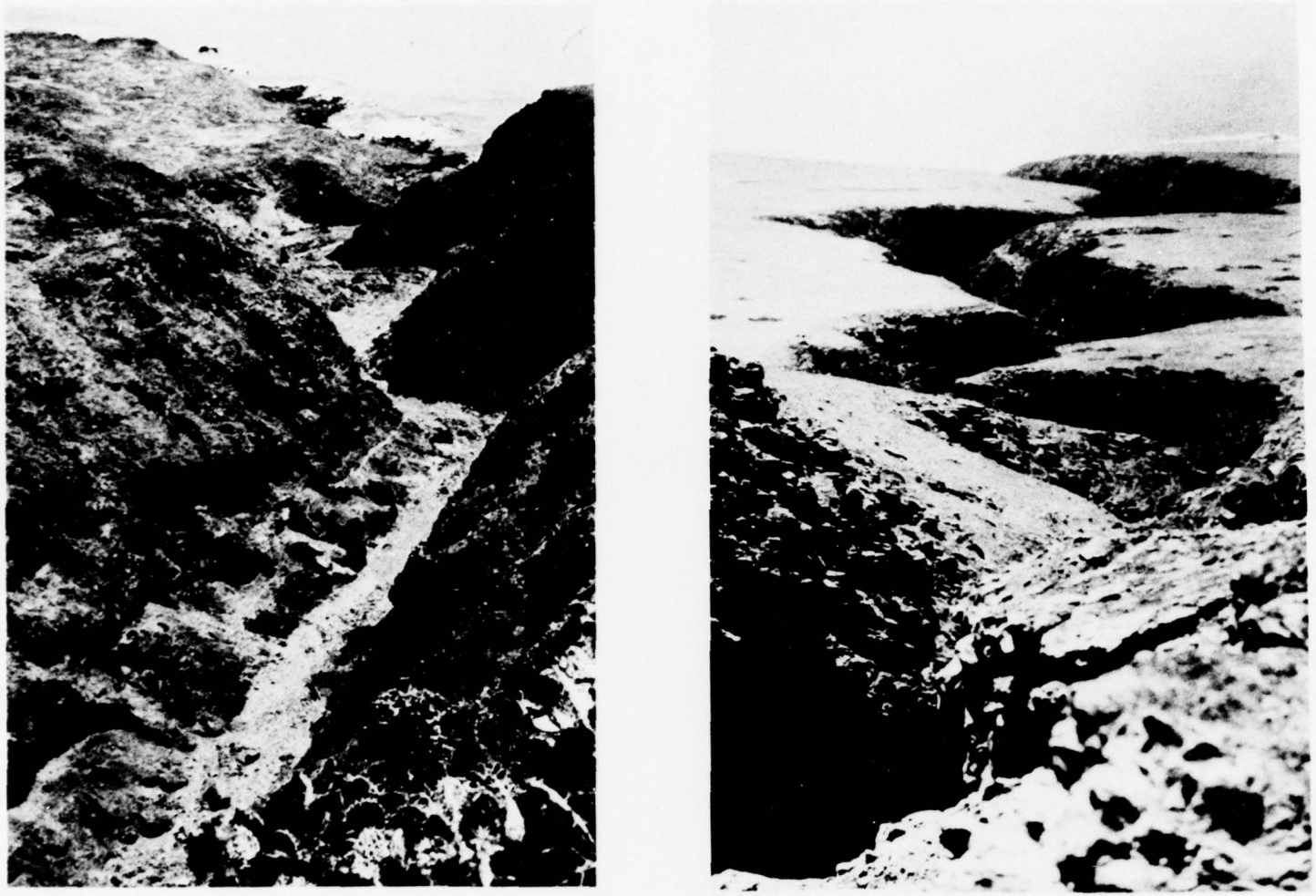

Figure 10. Many steep-sided canyons slice through the marine terraces on the southwestern portion of the island, collectively comprising a diverse habitat for many island plant and animal species.

Figure 11. Sand dunes near the northwestern shoreline.

Figure 12. Sand molds of vegetation, cemented by calcium carbonate, are suggestive of a moister climate in the island's past.

Figure 13. Massive solidified caliche soil. It was formed over a considerable period of time beginning with the sea level lowerings of the last ice age and is primarily composed of calcium.

from the Miocene shark Carcharodon were found on the island. Remarkably well-preserved fossil whales, fishes, sharks, and seaweeds, as well as microscopic radiolaria, foraminifera, and other fossil organisms have also been found. Various sites on the island have revealed fossils entirely different from those found at other sites. For example, fragmentary fossil remains tentatively identified as from the Miocene sea lion Allodesmus have been found and represent the most southern record of this species in the Miocene.

In a number of locations on the island are sand deposits that closely resemble the sand beds in the marine sedimentary rocks of Miocene age. These older deposits consist of sand, silt, and clay that are chiefly old dune deposits but also include old beach sand and lagoonal deposits. The younger sand deposits, which consist of loose well-sorted gray windblown sand, form active or recently active dunes, principally near the northern end of the island. Land snail shells and sand molds of tree trunks and plant roots and stems are abundant locally. The sand molds are cemented by calcium carbonate and are called rhizoconcretions. The plants represented by the molds are all suggestive of a moister climate on the island in the relatively recent geologic past.

Currently San Clemente Island has a semi-arid maritime climate with cool summers and mild winters. Except for more fog and overcast conditions and some cooler year-around temperatures, the weather is similar to that of the Southern California coastal areas. One of the outstanding features of the climate is the small range in average temperature, both diurnal and seasonal. In both of these instances the range is only approximately six degrees Celsius (10°F). Wind is normally from the west-northwest and rarely exceeds 20 knots; the average wind speeds are under ten knots. Rainfall is slight – 16 cm (6.30 in) per year average – and occurs mostly during the months of November through April. The cloudiest period of the year is in the spring and summer though, quite often, the fog will burn off by late morning. The seas around the island are generally calm, with rough water conditions occurring only 11 percent of the time.

## CULTURAL HISTORY

Since islands have always been viewed in a unique and special light by mankind, it would be interesting to speculate on how the Channel Islands – and San Clemente, in particular – were viewed by their first inhabitants. Regrettably, speculation is almost all that we are able to do in reconstructing the island's earliest cultural history. An early authority on the Channel Islanders states that they were probably the most advanced, both materially and spiritually, of any of the Indians of the region, yet we know almost nothing about them. Our knowledge has progressed little since the time of his statement.

The Channel Island Indians – "Canalinos" as they were called by the Spanish explorers of the sixteenth century – had probably lived in the Channel Island region for thousands of years before the first tentative contact by Western man. There is some evidence in the northern Channel Islands that man may have occupied the islands as early as 35,000 to 40,000 years ago. However, the prevailing view holds that the mainland coastal region was occupied from about 7,000 to 8,000 B.C. and that the northern Channel Islands were occupied from about 6,000 B.C.

The first reference to the Canalinos in recorded history was made by Cabrillo in the log of his voyages of 1542. He reported that they depended heavily on the sea for food, used


Figure 14. Map of California and its off-shore islands as conceived of by the Spanish explorers. It was made in about 1656. (San Clemente Island is uppermost of the two islands to the left center of the California "island.")

stone knives, and made large wooden boats – the latter probably being the plank canoes unique to the region. Other sources also state that there was a great deal of variety in the fishing gear used by the Canalinos, from crescentic fishhooks made from abalone shells to nets and projectiles. While fishing was very important to the islanders, their subsistence is best characterized through its variety. Shellfish were also quite important to their diets, and acorns, seeds, roots, tubers, and greens were all probably consumed to a much lesser degree. Although an accurate description of their dwellings doesn't exist, they were probably constructed of a circular framework of poles bent toward the structure's interior and covered with woven grass mats. The size of the dwellings varies; their diameters were approximately 6.5 meters (21 ft), or even larger, and more than one family probably lived in each structure. Some of the settlements were, at least in part, seasonal. It is estimated that approximately 1,200 Canalinos inhabited San Clemente Island during prehistoric times.

In 1602, Sebastian Vizcaino, another Spanish explorer, was the next Westerner to make written mention of San Clemente Island. As with Cabrillo, his reference was also brief but he is credited with giving the island its present name. There is little further discussion of the Channel Islands until the mission period of the late eighteenth and early nineteenth centuries. However, there is evidence that ships of various nations visited the waters off California and the possibility does exist that some of these may have stopped at the islands.

With the establishment of the mission system along the California coast, the Island Indians made their first contact with European man. Despite the positive intent of these encounters, the early Padres spread disease faster than the religion and culture they represented. By 1850, the last of

what was later known as the Gabrielino Indians disappeared from San Clemente Island. As with so much that concerns Channel Island Indian culture, the present record of their past is hopelessly inadequate.

In 1848, at the conclusion of the war between Mexico and the United States, California and its off-shore islands, San Clemente among them, became part of the United States. About twenty years later, the U. S. Government began leasing the island to private individuals for sheep ranching purposes. This continued, with the lease changing hands several times, until 1934. At that time administration of the island was transferred from the Department of Commerce to the Navy.

The sheep ranching period was a colorful era in the island's history and a few remnants from that time may still be seen today. For example, at the southern end of the island, rows of weathered fence posts subdivide the island into large pastures. Not so obvious are ruins of various ranch and outbuildings, along with catchments and dams. Though no evidence remains, a large white stucco house was located at the north end of the island, and was used as ranching headquarters for over 25 years. Horses were raised, crops of beans and grain grown, and windmills pumped fresh water. Much myth and legend originate from this period.

Sport fishing has been popular in the vicinity of the Channel Islands ever since the turn of the nineteenth century and fishing was – and still is – excellent in the San Clemente Island area. The nineteenth century was a busy period in the island's history for, in addition to the other activities, abalone camps were established by Chinese fishermen along its coast. The meat was dried and sent to China; the shells were sent to Germany and were made into mother-of-pearl jewelry and inlays. There is also speculation that the Chinese fishermen smuggled laborers onto the U. S. mainland. As if there wasn't sufficient exploitation of the island and its resources at this time, fur trappers were also to be found in its vicinity. Prior to the turn of the century, they had drastically depleted the marine mammal populations – essentially wiping out the sea otter and northern elephant seal populations – and had moved on to other areas.

The island was later used by smugglers during Prohibition; in addition, prospecting parties have visited the island from time to time in search of various treasure purported to have been left there. One story asserts that an old Indian buried a fortune on the island, while another story states that one of the ranch hands did the same. The largest fortune left on the island, as the story goes, was the result of the wreck of a Spanish treasure ship in the early eighteenth century. Perhaps a fortune is yet to be discovered!

In closing this brief summary of the island's history, it may be appropriate to conclude with a statement made by LCDR S. E. Flynn. His brief history of San Clemente Island, published during World War II, concluded with the following:

> While standing on Mt. Thirst, the highest point on the island, one can survey it from end to end and it is hard to imagine how the Indian came out here and chiseled out an existence for himself while the white man has to rely on help from the mainland to subsist. One wonders which race was really civilized.

## BIOTIC DESCRIPTION

What is probably most significant about islands is the various forms of life that are its inhabitants. San Clemente Island's biotic communities are, collectively, specific examples of that set of circumstances which so well defines islands as the unique and wondrous places they are.

Figure 15. Rows of weathered fence posts are all that remain of pastures that once covered much of the island.

Figure 16. A photograph taken around the turn of the century and during the height of the sheep ranching on the island.

Since before the turn of the century, botanists have collected 311 different species of vascular plants on the island. Of them, 243 are identified as indigenous to the island; the remaining 68 are presumed to be introduced by man. Of the indigenous plants, 43 are endemic either to San Clemente or one or more of the other Channel Islands. This is the highest proportion of endemism within the insular group. Most of these plants represent populations of species once having wider ranges (relict endemism), and a few are considered to have evolved in response to the particular selective pressures present on the island (autochthonous endemism). Four endemic plants are now thought to be extinct, and other species, particularly the endemic trees, now exist only as reduced and local senescent stands. Feral animals permit no reproduction; seedlings are consumed as soon as they appear.

In the studies conducted during the last fifteen years, 29 of the higher plants have not been reported. Some of the missing plants may turn up deep in one of the unexplored canyons or on one of the precipitous slopes along the island's coast, but most of them have probably been eliminated permanently from the island by the goats, pigs, and other introduced grazing animals. Many species are clinging precariously to existence, and they too face the possibility of ultimate extinction. We will never be able to tell how many plants have been eliminated nor to what degree the plant community has been altered due to grazing by the feral goats before the arrival of the first botanists.

## TERRESTRIAL FLORA

The floral community of San Clemente Island consists primarily of grasses, dominated by various introduced Mediterranean annuals along with a number of native species. The northern end of the island and the uppermost of the marine terraces are most densely covered by natives, though some of

the terraces along the eastern escarpment support mixed fields. The southern end of the island and most of the terraces to the west are barren and are only intermittently covered by grasses, usually on the slopes as opposed to the plateau areas. On almost every slope, whether between marine terraces or in the canyons, cactus predominates. Prickly pear cactus is particularly common in the northern areas of the island and dominates, sometimes in association with snake cactus, the drier south-facing canyon walls. Cholla cactus is most common in the southern half of the island.

Typical chaparral-type species are almost entirely confined to the steep sides of canyons and the slopes and lowest marine terraces of the eastern escarpment. Lemonade berry is the most common shrub, with isolated patches occurring at the northern end of the island in drainages. Conspicuously absent from the shrub community are chamise, laurel sumac, ceanothus, sugarbrush, and red berry. They are all listed as occurring on the island but are extremely rare. At one time these species may have been widespread, particularly before the introduction of domesticated animals. In the same regard, it is thought that a relatively dense chaparral forest once existed at the southern, drier end of the island. Coast desert thorn is the primary shrub along the coastal marine terraces of the west for most of the length of the island.

Though they once had a wider distribution, trees are now confined to the canyons of the island and the escarpment on the east side. The most abundant tree, the Catalina cherry, especially dominates the western canyons but it is also common along the eastern slopes. The Island oak and Catalina ironwood appear to be basically confined to the eastern escarpment, though individuals and some isolated groves have been noted in the western canyons. The toyon or Christmas berry is scattered about the island but common to most canyons. By far the rarest tree on the island, the Mexican elderberry, is found only as isolated individuals or pairs in a few canyons. All tree species except the Catalina ironwood have living mainland relatives; the ironwood is a relict now isolated to the Channel Island system. Only fossilized forms are known from its former mainland range, which extended over much of western North America.

## TERRESTRIAL FAUNA

The native wildlife of San Clemente Island is an impoverished assortment of species from adjacent mainland communities, augmented by several unique organisms. Of the 36 breeding native inhabitants (excluding insects), eight are endemic to San Clemente Island and twelve are endemic to the Channel Islands collectively. This high degree of endemism is related to the size, complexity, and isolation of the island's ecosystem.

San Clemente Island also harbors eight introduced mammals. The feral goat has been the dominant ecological force on the island, except during the sheep ranching period, since their introduction 150 years ago. Their modification and simplification of the vegetative community has coincidentally altered the higher faunal community structure. At least three endemic bird races have become extinct due to feral animal influences. All remaining organisms have been influenced by exotic populations to some degree.

There are ten species or subspecies of land snails on San Clemente Island. All but two of them are endemic to either the island or to the Channel Island system. Two lizard species, the side-blotched lizard and the island night lizard, are the sole representatives of reptiles on the island. The latter is a Channel Island endemic genus, found otherwise only on

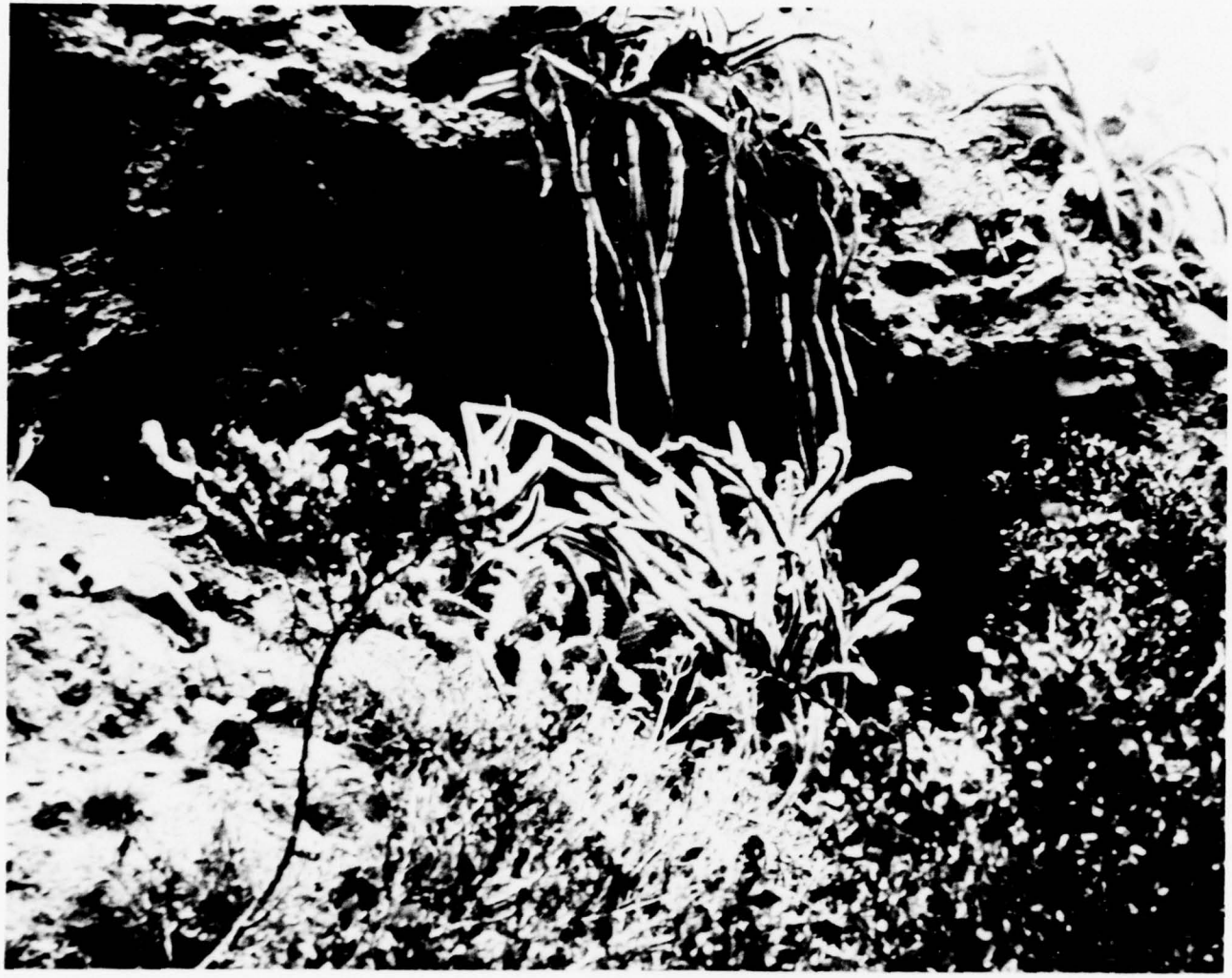

Figure 17. Various species of cactus predominate on the south-facing canyon walls, the hanging snake cactus being particularly striking.

Figure 18. Much of the island is covered by both native and exotic annual grasses. Prickly pear and cholla cactus are, of course, ever present.

Figure 19. Island trees are severely limited in range and are presently found only in the canyons and on the eastern escarpment. Goats destroy all vegetation within their reach, including seedlings.

Figure 20. The most dominant ecological factor on the island is the feral goat. Their destructiveness has resulted in a number of island plant and animal species being listed as endangered or threatened.

Figure 21. The side-blotched lizard, one of two lizard species which are the sole representatives of reptiles on the island.

San Nicolas and Santa Barbara Islands. San Clemente Island alone, however, supports a viable population of this species. The populations on the other islands are greatly reduced and may be near extinction.

The birds of the island have been well-catalogued and are surveyed periodically to keep the listings current. Of the nearly 200 species sighted on the island nineteen are known to breed. Ten races (subspecies) are endemic to San Clemente Island or are shared in common with one or more of the other Channel Islands.

The island fox, perhaps the most conspicuous of the Channel Island endemics found on the island, is a diminutive form of the mainland gray fox. It was probably distributed to San Clemente Island and the other islands of the southern group from the northern group by the resident Gabrielino Indians. Most of the Channel Islands support populations of the fox. This animal is not known well biologically or ecologically and is currently under study on the island.

There are a number of other mammals to be found on San Clemente Island. Bats have been seen or reported infrequently. They may be simply visitors to, rather than residents of, San Clemente Island. Five rodent species have been reported from the island, though the island deer mouse is the only one native to the island. The remaining species were introduced during the relatively short period following the island's discovery by modern man.

Many of the mammalian species introduced by modern man are the cause of the island's present ecological imbalance. Feral cats were released on the island sometime after the mid-1800's by sheep ranchers, presumably as pets as well as to control rodents around the residences. They are now well established and occupy most areas of the island. Black-tailed deer were introduced to San Clemente Island in about 1962 from mainland stock in central California. They are essentially confined to the northern third of the island, presumably because of range competition with the feral goat. The feral pig was introduced from Santa Catalina Island in about 1952. These animals range over a great deal of the island and, per pound, they are probably the most destructive animal on the island. They will completely uproot plants when feeding, destroying them in the process. All of these animals are detrimental to the island's native species and their removal from the island is part of the natural resources management effort.

## MARINE FLORA

Although the near-shore marine environment is not often included within the concept of an island, it is the terrestrial-marine interaction that uniquely characterizes the living communities of islands. Research is being completed in this area to better understand the diversity of life existing within the near-shore marine habitats of San Clemente. Kelp beds, submarine forests of giant algae, are found in abundance off San Clemente Island. The most extensive beds are found on the seaward side of the island. Beneath the kelp canopy an abundant and varied fauna is harbored. Historically, the sea otter enjoyed the protection of and food resources beneath these marine forests. Collectively, the Channel Islands support as near a pristine kelp habitat as can be found in California.

## MARINE FAUNA

The waters of southern California abound in various intertidal and near-shore marine faunal populations. There are a number of different crustacean species at San Clemente Island. Some of the most prominent ones are shrimp, hermit crab, and spiny lobster. Perhaps as many as 30 molluscan

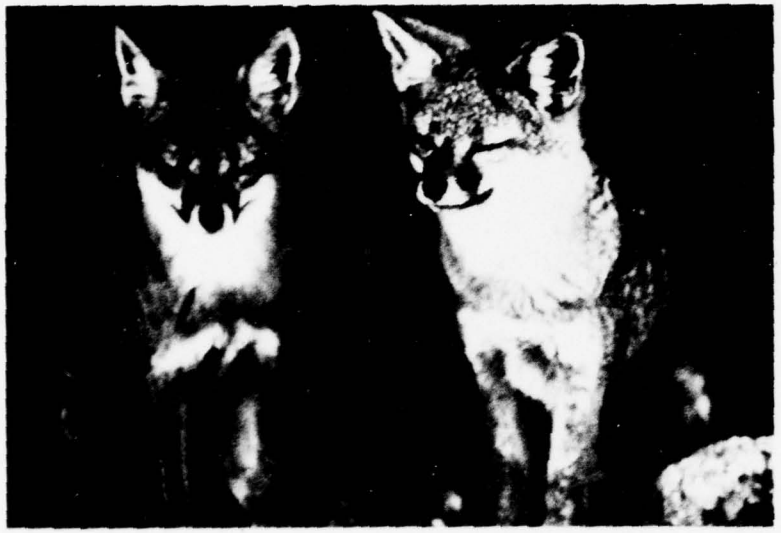

Figure 22. The island fox is a species unique to the Channel Islands and is much smaller than the mainland gray fox, its nearest relative. It is believed that the fox was first brought to the islands by the Canalino Indians.

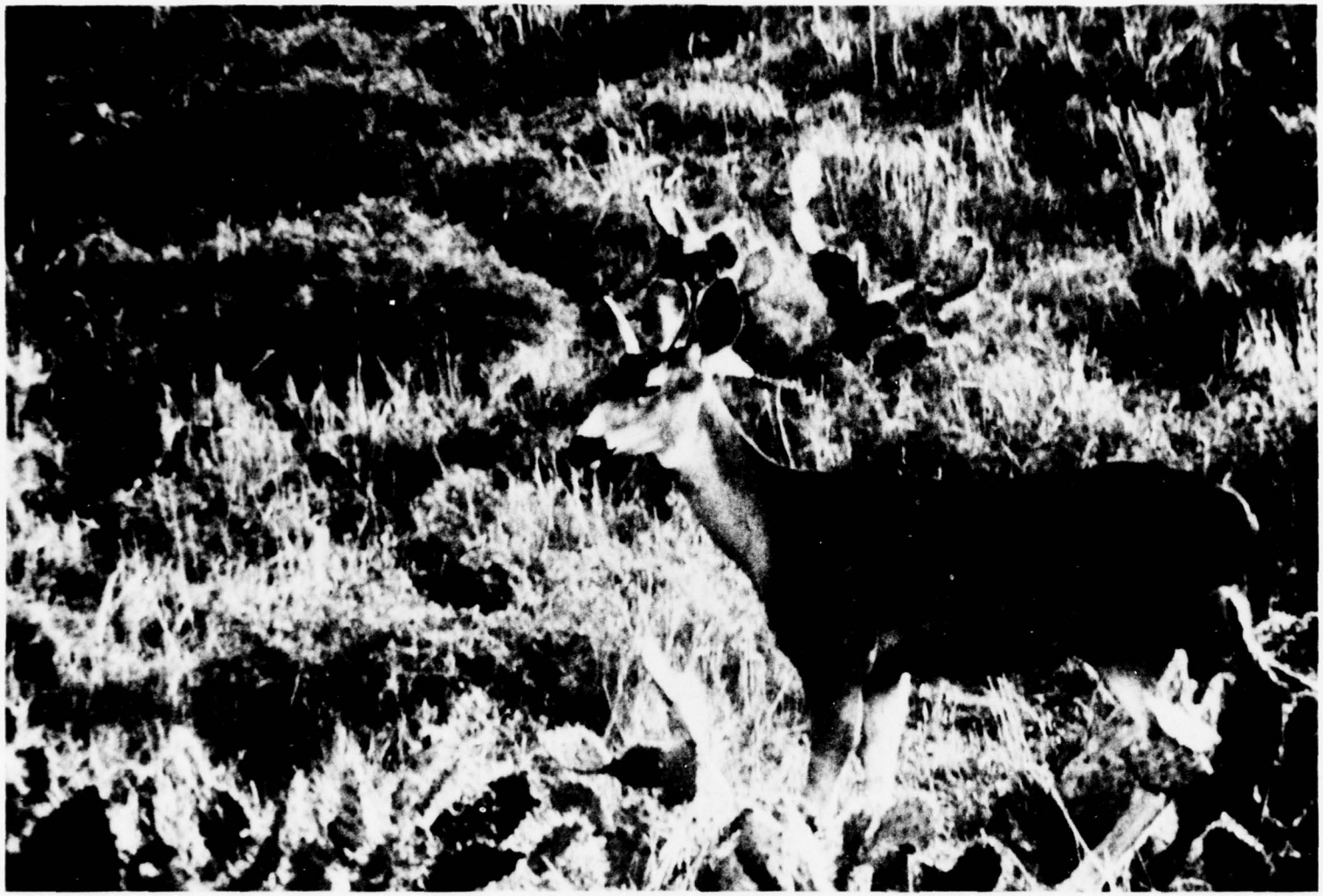

Figure 23. Black-tailed deer were the most recently introduced animals to the island and are also destructive to native vegetation.

Figure 24. Pound for pound, the feral pig is the most destructive feral animal on the island, completely uprooting plants while feeding.

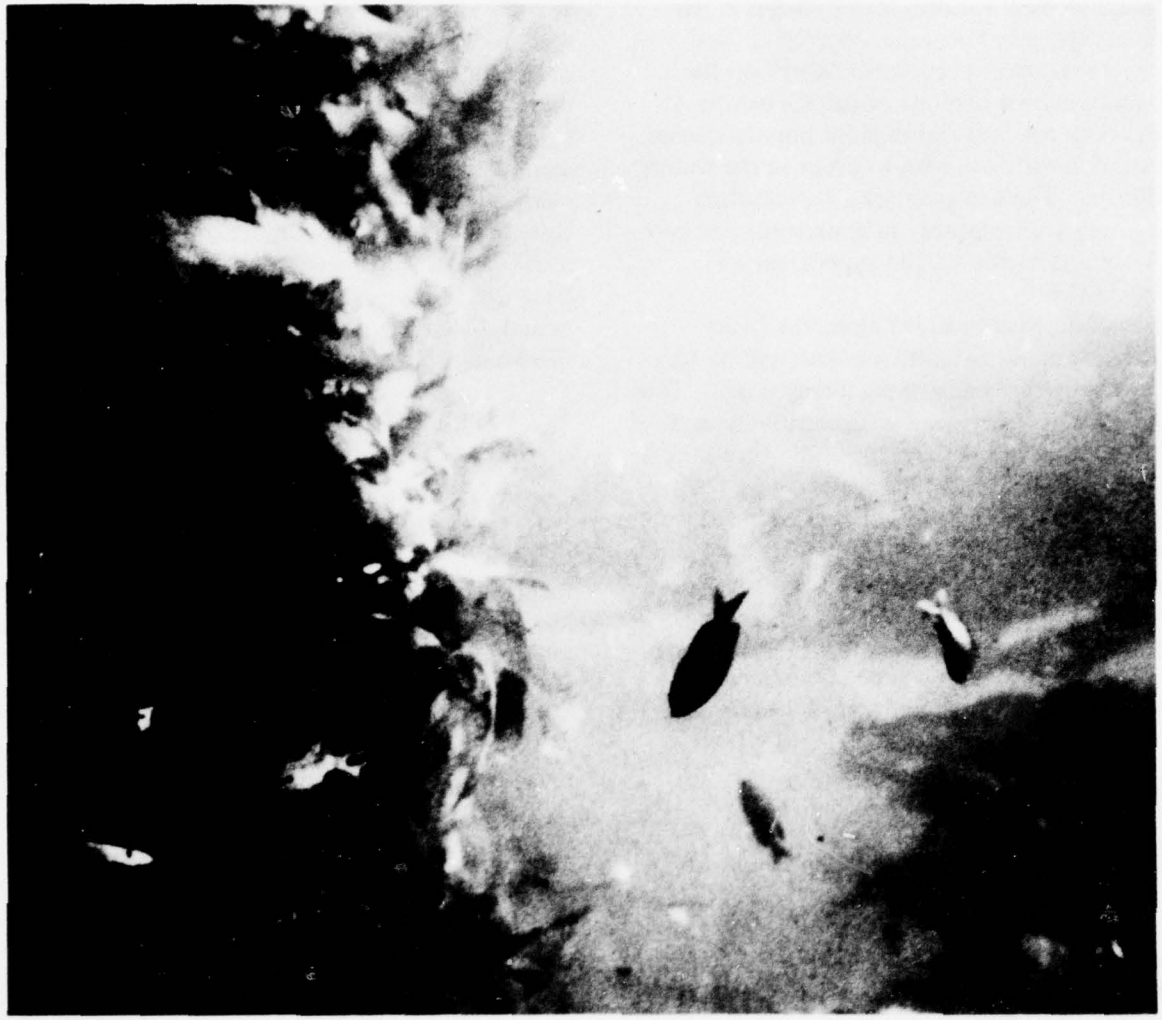

Figure 25. Extensive kelp beds, submarine forests of giant algae, are found surrounding the island, especially on the seaward side. The kelp habitat is quite important to marine faunal species.

species may be found along the shores of the island; in particular, four different species of abalone. Together, they form the basis for an extremely productive fishery on the island. The near-shore marine habitats of San Clemente Island also support both resident and migrant populations of perhaps 35 percent of all fishes known to occur in the waters off southern California. These populations, representing nearly 200 species, vary tremendously in abundance and ecological setting. A number of the species support an active commercial and sport fishery.

Marine mammals either visit or breed along the rocky shores of the island. As many as 2,000 sea lions and 50 harbor seals have been reported from a single survey count. The northern elephant seal visits the island occasionally in small numbers but does not now and perhaps never did breed there. The Stellar's sea lion and the Guadalupe fur seal have been reported as occasional visitors to San Clemente Island as well as to most of the other Channel Islands. The near-shore marine environment also supports resident populations of various dolphins as well as seasonal populations of porpoises. Migratory populations representing virtually all the large whales found in the eastern North Pacific may be seen seasonally off the island's shores, awesome in their silent power and beauty.

## ENDANGERED SPECIES

In a landmark final rulemaking effective September, 1977, the Federal Endangered Species Program of the U. S. Fish and Wildlife Service acted to further the preservation of an entire ecosystem by adding the first plants to the U. S. List of Endangered and Threatened Wildlife and Plants. One bird, the San Clemente loggerhead shrike, and four flowering plants – the San Clemente Island broom, bushmallow, larkspur, and Indian paintbrush – were declared endangered; two animals were also declared threatened – the San Clemente sage sparrow and the island night lizard. The rulemaking's recognition of the uniqueness of the island environment and, therefore, the need to protect the ecosystem as a whole was significant and has repercussions important to the management efforts on the island. Island-adapted species are particularly prone to depredations from accidentally or intentionally introduced exotic competitors, especially in the case of those species whose habitats are quite limited in extent. Destruction by exotics can occur in an unbelievably short period, often resulting in the extinction of a particular species in as little as a few years.

## IMPLEMENTATION OF NATURAL RESOURCES MANAGEMENT

In September of 1972 the Naval Ocean Systems Center joined with the U. S. Fish and Wildlife Service and the California Department of Fish and Game in a Cooperative Wildlife Agreement for the conservation, protection, and management of wildlife and natural resources on San Clemente Island. In accordance with the provisions of that Agreement, the signatory agencies cooperatively prepared a Natural Resources Management Plan, which was implemented in October 1973.

## THE NATURAL RESOURCES PROGRAM

A Natural Resources Program Office, established within the Public Works Department, implements the goals of the Natural Resources Management Plan by initiating conservation and management programs, by conducting or coordinating scientific research on the island concerning the ecosystem

Figure 26. Abalone beds, exposed here during a low tide, are also an important part of a productive fishery. Historically, the sea otter thrived on this mollusk. Four different species are to be found in the near-shore marine environment.

Figure 27. A bull California sea lion with his harem. Males often defend territories for as long as several months. Though fighting between males is not as vigorous as between larger elephant seals, it is almost constant and boisterous.

Figure 28. Sea lion colonies are easily disturbed. Escape is usually a stampede to the water.

Figure 29. Pups are born between May and mid-July. Within days they are accomplished swimmers.

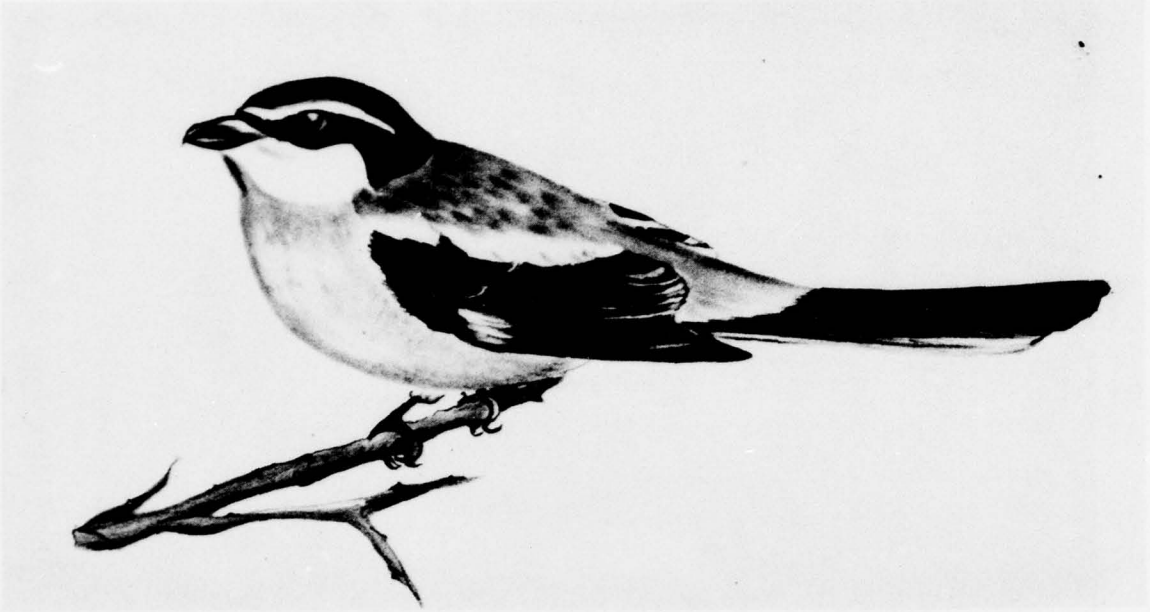

Figure 30. The Loggerhead Shrike is the most endangered of the native breeding birds of the island. Recent surveys estimate less than ten pairs.

Figure 31. The Island night lizard is an example of insular gigantism. Its closest relative on the mainland is only one-fifth its size. This gravid female is nearly six inches long.

Figure 32. The Natural Resources Management Committee. Chaired by the Public Works Officer, this committee is composed of members of the Natural Resources Program Office, state and federal wildlife and conservation agency representatives, members of the academic community, as well as representatives of NOSC's military and research personnel.

and its management, and by providing a focal point of contact for the Naval Ocean Systems Center in all matters pertaining to natural resources. The objectives of the Natural Resources Management Plan were established in response to the requirements of the applicable Federal laws and Navy directives (eg, DoD Directive 5500.5, OPNAVINST 6240.3E, and NAVFAC P-73), and in concert with national programs for conservation and protection of natural resources.

Management responsibility for program implementation is assigned to the Public Works Officer, designated the Natural Resources Management Officer by NOSCINST 11015.1A. The Natural Resources Management Officer is responsible for developing and implementing programs for conservation and management of wildlife and natural resources on lands controlled by the Naval Ocean Systems Center. A wildlife biologist, serving as Special Assistant for Natural Resources to the Natural Resources Management Officer, is responsible for the development, implementation, and coordination of specific natural resources management programs. The same instruction establishes the Natural Resources Management Committee, which serves in an advisory capacity to the Natural Resources Management Officer concerning programs of conservation and management on San Clemente Island. The Committee is comprised of members from federal and state conservation agencies, the local academic community with expertise in the management of natural resources, and cognizant commands and designated representatives of the Naval Ocean Systems Center. The Committee meets semi-annually, or as called by the chairman, for recommendation and review of natural resources programs and to assist with the long-range planning of such programs.

## BIOLOGICAL RESOURCES MANAGEMENT

Only recently have natural resources management programs incorporated a "total ecosystem perspective" as a basic theme. In the past most wildlife management programs have been dominated by "single species" approaches. As knowledge of the structure and function of ecological systems develops, it has become increasingly apparent that any scientifically sound resource conservation or management program must consider all components of the biotic community and their collective interactions. The ecosystem perspective is particularly imperative when dealing with relatively "closed" terrestrial systems, such as islands. The nature of insular systems demands careful consideration of proposed environmental manipulations, both in terms of kind and extent. Any conservation or management program will alter, to some degree, the stability of an insular community. But, whenever possible, these programs should be accomplished through reliance on natural biological processes. An ecological system should be allowed to evolve in response to native selective pressures rather than to direction by those pressures imposed upon it through man's intentional or inadvertent interference.

The management programs whose summaries follow are being implemented for the correction of influences imposed on the natural system by man. Each management program, whether directly or indirectly, is either a step forward in the reestablishment of native ecological conditions or a contribution to the conservation or protection of indigenous floral and faunal species. In other words, no program implemented will effect change counter to the natural evolution of the insular ecosystem, at least as it is understood by current scientific theories.

## REESTABLISHMENT OF NATIVE ECOLOGICAL SYSTEM

The first basic objective of the Natural Resources Management Plan is to reestablish, as closely as possible, the native ecological conditions within the island's ecosystem. Since feral animals are collectively the most significant exotic impact to the survival of most endangered or threatened life forms, their removal is imperative. These animals, specifically deer, pigs, goats, and cats, are common mainland species and can be seen anywhere; there is no need to preserve them in the island's fragile ecosystem. The same cannot be said for the island's native plants and animals.

## FERAL ANIMAL REMOVAL PROGRAM

By far the most destructive animal on the island is the feral goat, and, as such, it is the primary focus of the feral animal removal program. Since the time of their arrival on the island, perhaps 200 years ago, the goats have destroyed a significant portion of the island's vegetative community, and consequently, have altered the food chain and habitat for all higher forms of life. In combination with the damage resulting from the sheep ranching period, the goat has produced an ecological disaster. There is a great deal of speculation as to exactly how and when it arrived; the record isn't clear. The fact remains that it is a breed of Spanish goat and this has led to speculation that some goats may have been left on the island by Spanish explorers, such as Cabrillo or Vizcaino, or by others who followed. A practice of the time was to leave animals on islands as a living larder for the return voyage. What is considered a more plausible explanation purports that the goats were left by fishermen of the late eighteenth or early nineteenth centuries for the same reason.

Before any removal methods were implemented, a detailed study was made of the abundance and distribution of the feral goat population. In addition, the study also attempted to catalog movement and behavioral patterns which could be exploited to reduce the population. Scientific literature, particularly relating to areas with similar problems, was studied to gain insights concerning specific removal methods. Three methods were finally chosen from this preliminary work: trapping, herding, and hunting. All phases of the removal program were accomplished by contract at no cost to the government. In addition, volunteer Navy personnel on the island and students from San Diego State University and the United States International University (Elliott Campus), coordinated by the Natural Resources Program, were also of significant and continuing help to the feral animal removal effort. These methods were implemented, in stages, from 1974 through 1976.

Water trapping was the first method to be employed. This was done primarily during the drier periods of the year. Natural or artificial water sources were fenced; first, in a manner which allowed the goats to enter and leave freely, and later, with a ramp constructed in such a way that the goats were able to enter but not exit the trap (see photo). Whole herds were captured with this method. Nearly 2,000 animals were captured and shipped to the mainland. Feral pigs were also captured by the water trapping method.

The second method, herding, was more complex and utilized a great deal of volunteer help. Information compiled concerning the movement patterns of the goat herds was used in placing drift fences. The goats were herded up the canyons by people on foot, along the drift fences and into box traps. The traps were positioned so as to exploit the natural features of the terrain; and such that an individual box trap could be used a number of times by repositioning the drift fences that extended from it. Sometimes, the drift fences were as much as one-half mile long. The traps were also located so that the penned-up animals could be readily loaded on trucks for their

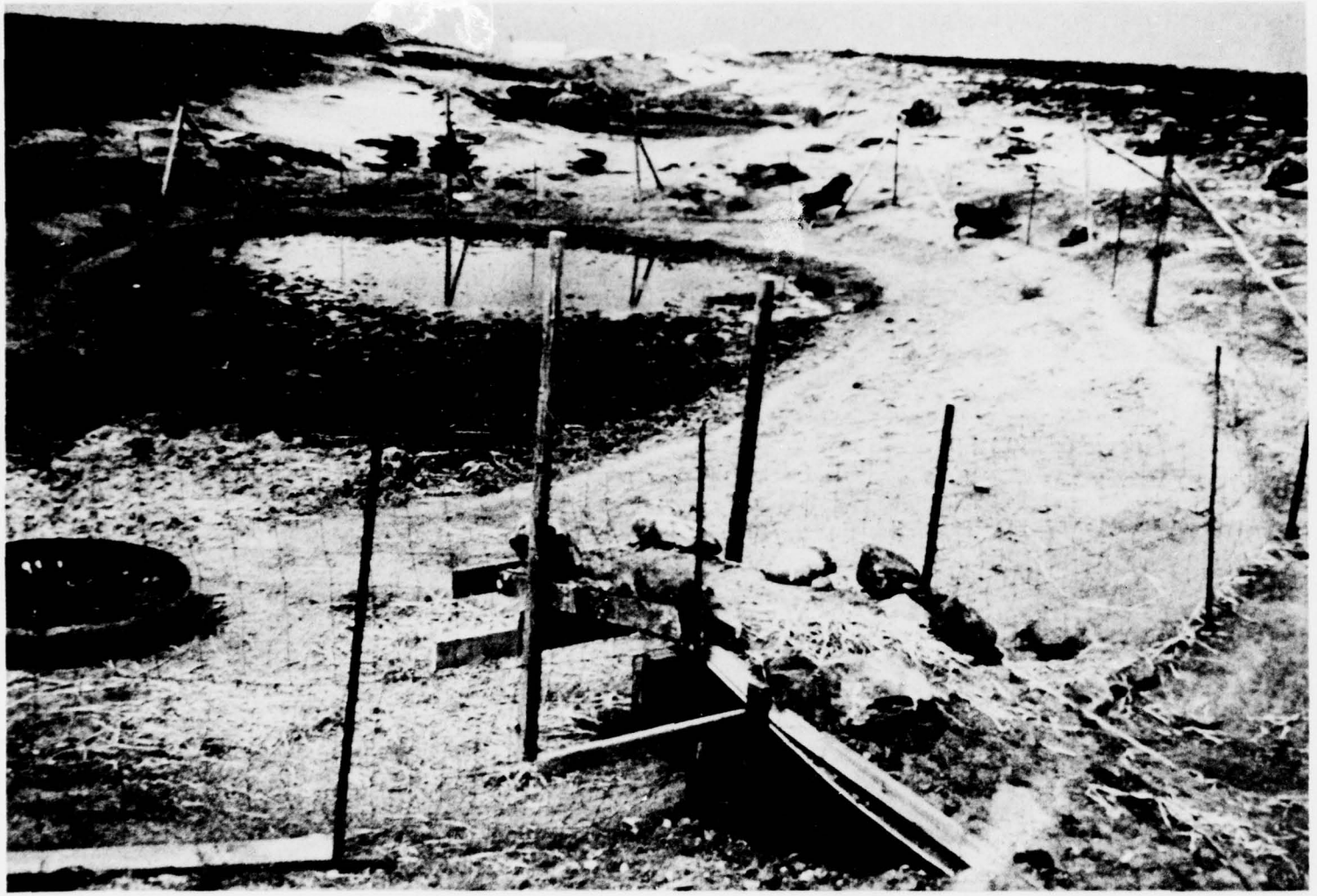

Figure 33. A feral goat water trap. The first method to be used as part of the goat removal program, it was most effective during the dry season.

Figure 34. Feral goats awaiting shipment to the mainland.

transport to holding pens and subsequent removal by barge from the island. As areas were cleared of the feral goat, the traps were repositioned in new areas. Over a period of two years, nearly 10,000 animals were captured in this manner.

Each method of the removal program was instituted only after the previous method was found to no longer be successful enough to warrant its continuation. That is, each of the methods had a limited applicability necessitating the follow-through with a different program.

The last method to be implemented was a sport hunting program. This was accomplished by a one-year contract. The contractor arranged for hunters to come to the island, provided meals and lodging, supplied licensed guides, and butchered and packaged harvested animals. These hunts were carried out systematically, under supervision or explicit instructions, and in accordance with federal and state game regulations.

The following table lists statistical information relating to the accomplishments of the various methods and the removal program in general. As these methods were being implemented, ongoing assessments were made to determine rates of accomplishment. Questions were asked concerning present effectiveness, projections for continued and future use, and what, if anything, could be done to improve the particular method under use. New techniques that came to the Program's attention, as well as contacts with other agencies dealing with similar problems, were also explored.

Further research is needed to accomplish the final removal of the feral goat population. Behavioral characteristics of the animal which can be exploited for removal programs will be evaluated and implemented in concert with other suitable methods. Since each method is limited in effectiveness due to the adaptability of the goat herd, combined and concentrated efforts are needed. Until the goat population can be removed from the island faster than it can reproductively replace harvested individuals, the removal program will be an ongoing one.

TABLE 1. STATUS OF THE FERAL GOAT POPULATION.

| | | Approximate Number of Animals |
|---|---|---|
| Feral Goat Population Census, Summer 1972<br>total animals counted: 6871 | | Population Estimate: 10,000 |
| Feral Animal Removal Programs, August 1972 – March 1977 | | |
| Contractor | Methods | Animals Removed |
| Grumbles & House<br>8/72 – 8/73 | Water Traps<br>Herding | 679<br>1,794 |
| Bar Four Ranch<br>8/73 – 10/75 | Water Traps<br>Herding<br>Miscellaneous | 1,217<br>7,887<br>652 |
| Bar Four Ranch<br>2/76 – 3/77 | Sport Hunting | 4,234 |
| | | Total Removed: 16,463 |
| Feral Goat Population Census, 16-17 April 1977<br>total animals counted: 1249 | | Population Estimate: 1,500 |

## EXOTIC PLANT REMOVAL PROGRAM

The exotic plant removal program is another conservation effort to reestablish, as closely as possible, original ecological conditions on San Clemente Island. Numerous exotic plants

Figure 35. Once the major herds were captured and removed from the island, it became much more difficult to remove this highly adaptable animal. Many of the remaining animals are located in inaccessible canyons or on the eastern scarp.

were introduced as feed during the sheep ranching period of the late nineteenth century, and they have come to dominate much of the island. Examples include a number of different varieties of grasses and oats. Few exotics have been introduced recently. Those that have were probably brought to the island on construction equipment and other vehicles covered with seed-bearing mud from the mainland. These recent introductions include such things as fennel and tumbleweed (catchfly) – the latter having become a particular problem.

The Natural Resources Program has established a prioritized list (see table 2) for the removal of exotic plants, based on the distribution, threat of spreading, competitive relationship to the native plant community, and ease of eradication of each species. The primary eradication method will employ spraying suitable herbicides on exotics. Procedures will begin with roadsides, since the greatest number and variety of exotics are found in these areas. Controlled burning is a second technique that will be used in some areas to effectively eradicate the exotics. And in still other areas, manual weeding will be employed.

TABLE 2. EXOTIC PLANT REMOVAL PROGRAM.

Priority I Species: Seek and destroy

WILD

| | |
|---|---|
| Typha domingensis Pers. | Convex Cat-Tail |
| Typha latifolia L. | Flat Cat-Tail |
| Chrysanthemum coronarium L. | Garland Chrysanthemum |
| Brassica geniculata (Desf.) J. Ball. | Mustard |
| Brassica rapa L. ssp. sylvestris (L.) Janchen. | Field Mustard |
| Raphanus raphanistrum L. | Jointed Charlock |
| Bassia hyssopifolia (Pall.) Kuntze | Bassia |
| Salsola iberica Sennen & Pau | Russian-Thistle |

TABLE 2 (Continued).

| | |
|---|---|
| Oxalis pes-caprae L. | Bermuda-Buttercup |
| Plantago lanceolata L. | English Plantain |
| Limonium perezii F. T. Hubb. | Statice |
| Solanum nodiflorum Jacq. | Nightshade |
| Foeniculum vulgare mill. | Fennel |

CULTIVATED

| | |
|---|---|
| Nicotiana glauca Grah. | Tree Tobacco |
| Ricinus communis L. | Castor-Bean |
| Ulmus parvifolia Jacq. | Chinese Elm |
| Opuntia ficus-indica (L.) Mill. | Tuna |
| Acacia longifolia Willd. | Golden Wattle |

Priority II Species: Eradication whenever found

WILD

| | |
|---|---|
| Avena sativa L. | Cultivated Oats |
| Bromus mollis L. | Soft Chess |
| Bromus rubens L. | Foxtail Chess |
| Cynodon dactylon (L.) Pers. | Bermuda Grass |
| Hordeum vulgare L. | Common Barley |
| Lolium perenne L. spp. multiflorum (Lam.) Husnot | Italian Ryegrass |
| Lolium perenne L. ssp. perenne | English Ryegrass |
| Lolium temulentum L. | Darnel |
| Triticum aestivum L. | Wheat |
| Carpobrotus edulis (L.) Bolus. | Hottentot-Fig |
| Centaurea melitensis L. | Tocalote |
| Conyza bonariensis (L.) Cronq. | Fleabane |
| Conyza canadensis (L.) Cronq. | Horseweed |
| Hypochoeris glabra L. | Cat's-Ear |
| Madia sativa Mol. | Chile Tarweed |
| Senecio vulgaris L. | Common Groundsel |

TABLE 2 (Continued).

| | |
|---|---|
| Sonchus asper (L.) Hill. | Sow-Thistle |
| Sonchus oleraceus L. | Sow-Thistle |
| Sonchus tenerrimus L. | Sow-Thistle |
| Brassica nigra (L.) Koch | Black Mustard |
| Sisyrimbium irio L. | London-Rocket |
| Beta vulgaris L. | Garden Beet |
| Chenopodium murale L. | Goose-Foot |
| Melilotus albus Desr. | White Sweet-Clover |
| Erodium botrys (Cav.) Bertol. | Storksbill |
| Marrubium vulgare L. | Horehound |
| Malvella leprosa (Ortega) Krapov. | Alkali-Mallow |
| Polygonum arenastrum Bor. | Knot-Weed |
| Rumex crispus L. 1 | Dock |

CULTIVATED

| | |
|---|---|
| Eucalyptus globulus Labill. | Blue-Gum |
| Myoporum laetum Forst. f. | Myoporum |
| Lampranthus sp. | Ice Plant |
| Heteromeles arbutifolia M. Roem. ssp. arbutifolia | Toyon |
| Pelargonum zonale (L.) Ait. | Garden Geranium |

Priority III Species: No threat of spreading but should be eradicated when found

| | |
|---|---|
| Phalaris paradoxa L. | Canary Grass |
| Vulpia myuros (L.) Rydb. | Fescue |

Priority IV Species: Too well established for effective eradication

| | |
|---|---|
| Avena barbata Brot. | Slender Oats |
| Avena fatua L. | Wild Oats |
| Bromus diandrus Roth. | Rip-Gut Grass |

TABLE 2 (Continued).

| | |
|---|---|
| Gastridium ventricosum (Gouan) Schinz & Thell. | Nit Grass |
| Hordeum glaucum Steud. | Wild Barley |
| Hordeum leporinum Link. | Foxtail |
| Lamarckia aurea (L.) Moench. | Goldentop |
| Parapholis incurva (L.) C. E. Hubb. | Sickle Grass |
| Phalaris minor Retz. | Mediterranean Canary Grass |
| Poa annua L. | Winter Grass |
| Polypogon monspeliensis (L.) Desf. | Beard Grass |
| Gasoul crystallinum (L.) Rotm. | Ice Plant |
| Gasoul nodiflorum (L.) Rotm. | Ice Plant |
| Cakile maritima Scop. | Sea-Rocket |
| Capsella bursa-pastoris (L.) Medic. | Shepherd's-Purse |
| Cerastium glomeratum Thuill. | Mouse-Ear Chickweed |
| Silene gallica L. | Catchfly |
| Spergularia bocconii (Scheele) Foucaud. | Sand-Spurry |
| Stellaria media (L.) Vill. | Chickweed |
| Atriplex semibaccata R. Br. | Australian Saltbush |
| Medicago polymorpha L. | Bur-Clover |
| Melilotus indicus (L.) All. | Yellow Sweet-Clover |
| Erodium cicutarium (L.) L'Her. | Filaree |
| Erodium moschatum (L.) L'Her. | Filaree |
| Malva parviflora L. | Cheeseweed |
| Galium aparine L. | Bed-Straw |

Although several acres of mustard and some fennel have been eradicated at the northern end of the island, evaluating the accomplishments of the program is premature at this time. Future efforts will utilize the results of a comprehensive survey of exotic plant distribution and abundance to direct and concentrate removal efforts. In an effort to approach the problem from the other direction, all new construction

contracts require thorough spray cleaning of vehicles and equipment brought to the island to reduce possible exotic introductions. And lastly, landscaping efforts as part of the base beautification plan will use native plant species wherever possible.

## CONSERVATION AND MANAGEMENT OF *ENDANGERED SPECIES*

The second major objective of the Natural Resources Management Plan is the conservation and management of endangered species.

The 1977 rulemaking by the U. S. Fish and Wildlife Service, which declared seven San Clemente Island species either endangered or threatened, was explicit in recognizing the need to protect an island ecosystem as a unit. Since relatively few species are able to migrate to islands and survive, those species that do manage to colonize often become a dominant aspect of the environment. The species that are able to adapt develop over a period of thousands of years as a unit. This interrelatedness among the island species must be preserved. Since insular populations evolved in the absence of more hardy and aggressive mainland species, they are in a particularly precarious position if exotics are introduced. For example, the island's plant community developed without the need for protection against grazing animals. When goats and sheep were introduced, their voracious appetites quickly created the island's present ecological imbalance. Should the remaining grazing animals be allowed to continue their destruction of the plant community, other species dependent upon the plant community for food and habitat may also become extinct. To adequately protect the island's endangered and threatened species, a number of different programs were implemented. The Biological Assessment Program is the most basic of these.

## BIOLOGICAL ASSESSMENT PROGRAM

The objectives of this program are to assess the status of the island's biological community, including each endangered or threatened species, to provide data required for the preparation of an environmental impact assessment of the Natural Resources Management Plan, and to identify sensitive biological areas which may be in need of special management attention.

First of all, the program has inventoried the major organisms inhabiting San Clemente Island and determined their distribution. In addition, status surveys are conducted yearly to monitor population changes that may have occurred. These yearly updates involve (a) those species that are now on federal or state endangered or threatened species lists, (b) those species that are proposed for inclusion on these lists, and (c) those additional native species which the Natural Resources Program considers sensitive and that may be in need of special management consideration. An example of this last category is the elderberry tree. There are probably less than thirty individuals on the island existing as isolated senescent stands. Though the elderberry tree is found throughout North America and it doesn't occur on any endangered species list, its population on the island is so severely reduced that only special protective measures will insure its survival. Insular ecosystems, as the Federal Endangered Species Program rulemaking of September, 1977 points out, must be protected in their entirety. Although many species don't fall under specific legislation, they are important to the survival of the ecosystem and are, therefore, deserving of protection.

Three San Diego State University researchers were contracted to conduct population surveys. They divided the

biotic community into three separate areas, monitored indicator species at various ecological levels on the island, and submitted reports on their findings. One researcher studied foxes, lizards, and insects; a second plants and birds; and the third sea lions, snails, and rodents. (These reports are on file at the Program Office.) Indicator species are those plants and animal populations most sensitive to, and most representative of, changes in the ecological structure of San Clemente Island. The study of Loggerhead Shrikes, a species that requires a very specific nesting habitat, gives a much clearer picture of changes in the habitat than does, for example, study of doves which do not require as specific a habitat.

## ENDANGERED SPECIES SURVEYS

One of the major requirements of the Federal Endangered Species Act is that the abundance, distribution, and critical habitat of each endangered species be ascertained. This information is used in different ways. First, it is shared with cognizant state and federal conservation agencies in order to promote the recovery of the affected species. Second, it is used to develop positive programs for the preservation of critical habitats. And third, broad-scope management objectives can be formulated on the basis of the needs of each species.

To date, the San Clemente sage sparrow is the only species to have been studied. During the 1976 calendar year, a comprehensive survey determined that fewer than two-hundred individuals inhabit the island. Though their population is relatively small, it appears to be stable or increasing. Numerous juveniles were observed in flocks following the breeding season. In addition, their present habitat was found to be more extensive than previously reported and includes the lower coastal plateaus on the northwestern and central portions of the island. Study results were instrumental in changing the status of the bird from endangered to threatened when comments were solicited by the U. S. Fish and Wildlife Service.

These status surveys should become quite important in the future by giving the Natural Resources Program a better feel for what specific kinds of management will be needed in the case of each individual endangered species. This management would be in addition to the ongoing feral animal and exotic plant removal programs which are quite broad in scope and may not be responsive enough for specific populations.

## NATIVE PLANT NURSERY

Because of adverse effects of the feral grazing animals, the native vegetative community has been drastically reduced and restructured. Most endemic and many native species are now isolated, occupying the precipitous sides of canyons and similar areas isolated from feral animal use. Some of these plants may not survive on their own.

To ensure the continued survival of these species, a horticulturist was contracted to collect seeds, germinate them, and establish a nursery on the island in as natural a situation as possible. The nursery has a two-fold purpose. First, by collecting seeds of each species from widely separated locations on the island, a diverse genetic stock will be maintained. Second, plants propagated at the nursery will be used to establish a seed bank. Seeds will be collected, stored, and eventually planted in areas that have historically supported such populations.

A suitable site was chosen for the nursery on the northern portion of the island. Those species planted there to date were initially watered and provided with fertilizer to ensure survival of the stock. Approximately twenty-five different species are presently in the nursery, with six to eight plants each. A few additional nursery sites in different soils may be developed in the future since not all species may be able to

Figure 36. The island fox. Weighing is one of many parameters necessary to determine the population's status. Five separate traplines were set and the animals were tagged to note recaptures.

Figure 37. Age was determined by analysis of tooth wear on the first molar.

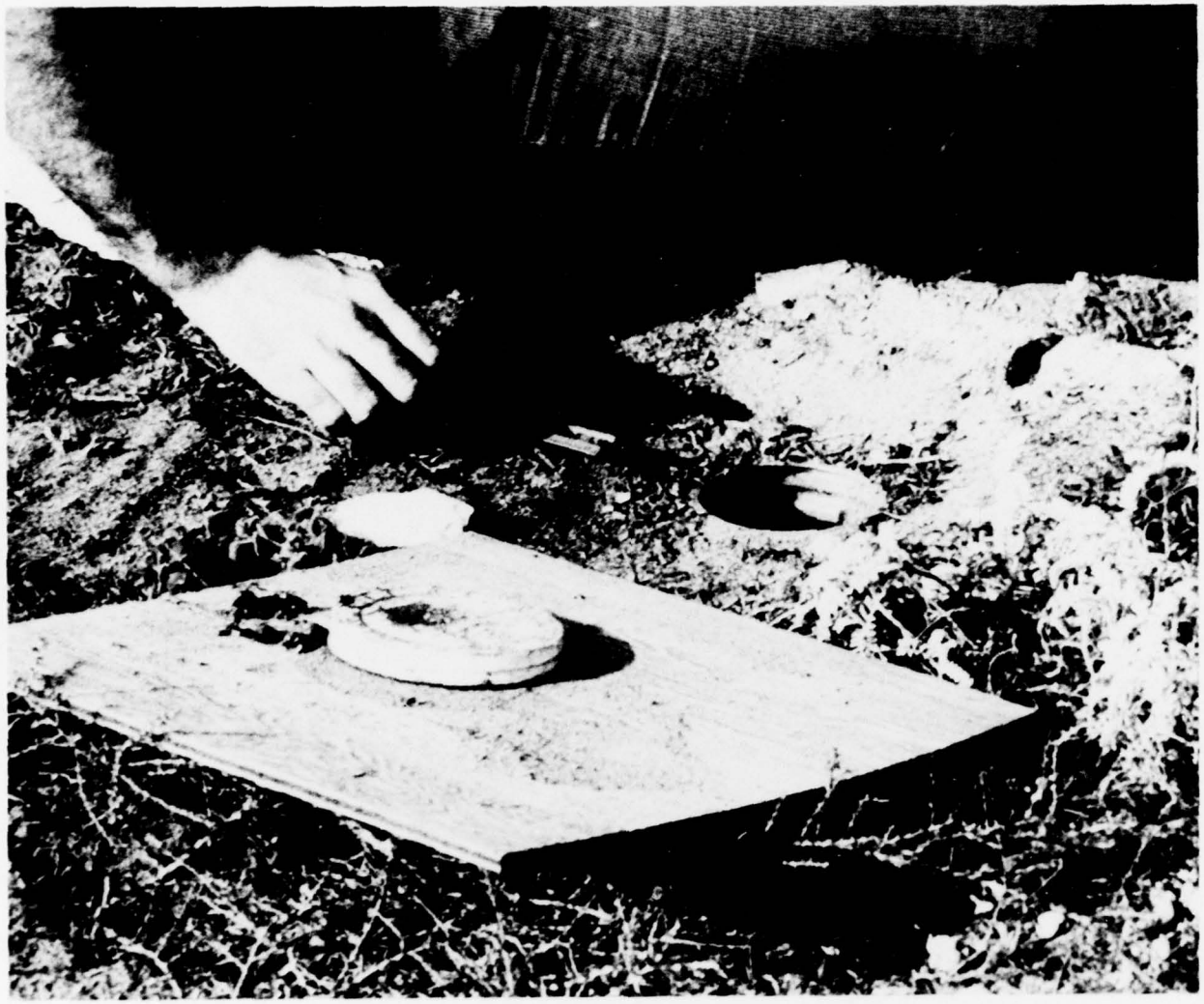

Figure 38. A quadrat pitfall system, using plastic one-gallon containers with "roofs," was deployed to study the island lizard population over a fifteen-month period.

Figure 39. Vegetative community plots were delineated in various habitats to determine species composition. The plots were monitored quarterly during one year.

Figure 40. A census of marine mammals was taken twice yearly with the number of new pups of particular interest. Since the California sea lion breeds on land, it requires isolated and undisturbed stretches of coastline for breeding and pupping. The western shore of San Clemente Island is an ideal breeding ground for this species.

Figure 41. The sage sparrow, a small and secretive bird, is seen only during the breeding season when pairs vigorously defend their territories. At this time, the male is often seen perched high on vegetation. Nests are well camouflaged and are almost never found.

Figure 42. White stakes mark the locations of cultivated endangered, threatened, or "sensitive" species in the native plant nursery. Genetic diversity is ensured by collecting seeds of each species from as widely separated locations as possible.

Figure 43. A southern bald eagle being trained for eventual release on the island. A radio-telemetry antenna extends from the bird's tail feathers.

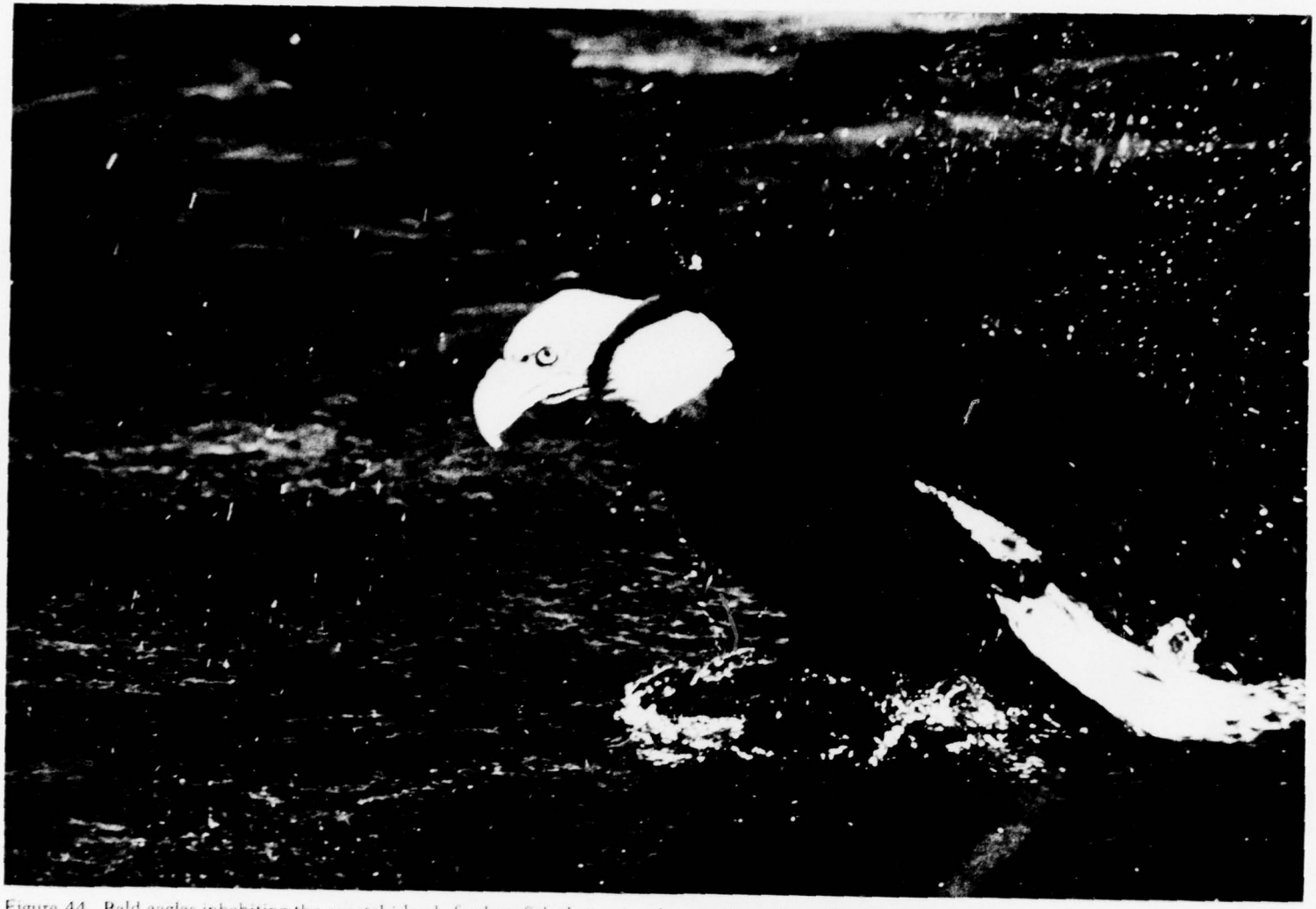

Figure 44. Bald eagles inhabiting the coastal islands feed on fish that swim close to the surface. Even large fish are snatched from the water by powerful talons.

Figure 45. An osprey above its nest. The Natural Resources Program anticipates the reintroduction of other species, such as the osprey, which were once native to the island.

thrive in the present location. A follow-up contract is anticipated to collect more seeds to further increase the genetic diversity of the species already established in the nursery and to propagate those plants that are on the Natural Resources Program sensitive list.

When the feral animal removal programs are completed, or when areas become protected from the grazing of these species, a replanting program will be initiated. There are no plans, however, for a massive reseeding effort. The objective is to provide for the recovery of each species, but insofar as possible, within the biological boundaries set by the native system.

## REINTRODUCTION PROGRAMS

The destruction of the vegetative community by feral animals has caused a variety of species to become extinct on San Clemente Island, and this has been especially true concerning wildlife. Habitats for several endemic bird races have been drastically reduced or eliminated, resulting in the extinction of these species only recently. These include San Clemente Island subspecies (or races) of Bewick's wren, Rufous-sided Towhee, and the song sparrow. Since all of the endemic races forced to extinction are sedentary in nature, many years may be required for natural emigration from adjacent insular habitats to reestablish viable populations on San Clemente Island. Once current programs have allowed vegetative habitats to recover, reintroduction programs, primarily involving birds, will be initiated. Appropriate sites will be designated as potential reintroduction areas for each species, and when these habitats become suitable, breeding pairs from adjacent islands will be trapped, transported, and released.

The present reintroduction program concerns reestablishing the bald eagle on San Clemente Island. The bald eagle is an endangered species throughout most of the continental United States. Although it was an island native at one time, it hasn't bred there since about 1930 and was last sighted in the mid-1940's. However, since the island is isolated and since a controlled access policy is maintained by the Navy, the near-shore marine environment from which eagles fish is nearly pristine in nature. This location is therefore considered ideal for a reintroduction program.

In September 1976, the Center joined with the Alexander Lindsay Junior Museum, Walnut Creek, California in an agreement to accomplish a Bald Eagle Recovery Program. The objectives of the Program are threefold; first, to develop and evaluate methods for the rehabilitation and release of large birds of prey, second, to reintroduce the bald eagle to San Clemente Island, and third, if feasible, to establish a breeding unit from which other areas of California could be repopulated.

Three bald eagles have been released to date. The first, named "Ishi" by program personnel, had been in captivity far too long and had become fixated to humans. He was unable to adjust to the wild and was, after extensive training unsuitable for reintroduction. The second eagle brought to the island was called "Ulyssa," a six-year old female, which was released from Seal Cove. She was monitored by radio-telemetry on the island for about four months. She responded well to training and was observed feeding normally. A third eagle, an immature female approximately three years old, was released and never sighted again. Neither bird was presumed on the island as of summer 1977. It is speculated that both migrated north, which is normal at this time, to areas close to where they were reared.

## PHYSICAL RESOURCES MANAGEMENT

Although no formal legislation protects San Clemente Island's physical resources, a number of the unique

paleontological and geological resources warrant protection and management. These resources are, in a sense, more "fragile" than the highly vulnerable biotic community since there is no mechanism available for their regeneration. Destruction, by whatever means, would be irreversible.

The major management effort in this area is directed at identifying the location of significant resources, and subsequently applying appropriate conservation techniques. Over the past several decades the Los Angeles County Museum of Natural History has conducted numerous surveys of the paleontological resources of the island. In early 1976 an agreement between the Center and the Museum was established to continue such surveys and to jointly review all proposed research concerning paleontological resources. The coordinated effort has led to the preparation of a preliminary map of significant resources identifying sites which should be studied further and identified for protection. Programs for management are currently under consideration.

In addition, explicit legislation which ensures the conservation and management of biological and cultural resources safeguards to some degree significant physical resources. For example, the reestablishment of the native vegetation, as called for as a consequence of other objectives of the Natural Resources Management Plan, will significantly decrease the effect of erosion. Likewise, as is often the case, if physical resources are incorporated within an area protected for other resources, their protection is coincidentally provided for. Finally, in consultation with other agencies tasked with the preservation of physical resources, such as the Bureau of Land Management, effective programs to minimize adverse effects will be implemented.

## CULTURAL RESOURCES MANAGEMENT

The broad goal of cultural resources management is to protect, preserve, and interpret nonrenewable resources that constitute a human record of San Clemente Island, specifically, such things as sites, artifacts, and structures. There are many Federal directives that further these goals, giving government agencies a specific mandate. Some of the more important ones include The Antiquities Act of 1906, The Historic Sites Act of 1935, The National Historic Preservation Act of 1966, The National Environmental Policy Act of 1969, and The Archeological and Historic Preservation Act of 1974.

Executive Order 11593 (1971), Protection and Enhancement of the Cultural Environment, reiterates the importance of these laws, stating that all federal agencies "shall (1) administer the cultural properties under their control in a spirit of stewardship and trusteeship for future generations, (2) iniate measures necessary to direct their policies, plans and programs in such a way that federally-owned sites, structures, and objects of historical, architectural or archeological significance are preserved, restored and maintained for the inspiration and benefit of the people. . . ." In addition, E.O. 11593 also requires Federal agencies to act "in cooperation with the liaison officer for historic preservation for the state or territory involved, to locate, inventory, and nominate to the Secretary of the Interior all sites, buildings, districts, and objects under their jurisdiction or control that appear to qualify for listing on the National Register of Historic Places."

The first step in fulfilling this mandate is being implemented by a general survey of the historical and archeological resources of the island. In consonance with the other

resource management programs, NOSC entered into an educational service agreement with San Diego Mesa College (San Diego, Calif.) in September, 1975. The nature of this program is four-fold: Primarily, the research is structured to locate, inventory, and assess all prehistoric and historic sites on the island and to prepare a written report on them. Secondly, salvage excavation will be implemented to recover any archeological and historical resources subject to possible loss from site destruction or deterioration. Thirdly, selected systematic excavations, in accordance with Department of Interior regulations, will be conducted to determine cultural affinities between San Clemente Island, the remainder of the California Channel Islands and the adjacent mainland. This analysis of cultural settings will be pertinent to the National Register nomination process previously mentioned. The excavations will also be considered in terms of stratigraphic information, and, concurrently, suitable material will be recovered for C-14 and amino-acid dating in order to establish a time baseline for the earliest occupations and subsequent cultural periods of the island. Lastly, a permanent museum will be established at Mesa College for representative archeological and historical materials obtained from San Clemente Island during the period of the contract.

Field work is conducted during the regular school year and summer session with the project archeologist and a field crew of as many as eighteen students conducting their field surveys on every other weekend. This schedule was begun in the fall of 1975 and will continue for several years. The work must be accomplished slowly and methodically to ensure that sites are neither missed nor inadvertently damaged. Although the present work focuses on completing a survey of the island's cultural resources, salvage archeology has been utilized in a few instances and a field station has been established to adequately process and identify artifacts.

Since the cultural history of the Channel Island region is so incomplete, the research efforts will add significantly to the further understanding of the area's earliest inhabitants. It would be premature to discuss the survey's findings in great detail but some points may be summarized. On the basis of some of the present radiocarbon dating, it is believed that a culture existed on San Clemente Island predating all known cultures there (approximately 8,000 years before present). In addition, evidence of subsequent cultural periods has also been discovered. One example concerns the Chinese abalone industry of the late nineteenth century. A significant number of artifacts concerning these activities on the island have been found and should aid in adequately describing what had only been known in the vaguest terms. "Horseshoe" stone circles, whose function had puzzled archeologists in the past, have been identified by the project archeologist as hearths used by the Chinese for processing abalone. Also, "doughnut-shaped" anchor stones, which had been previously attributed to pre-Columbian Asians, may also be artifacts of the same period.

The survey has also reported some disturbing news. Of the sites surveyed thus far, approximately one-fifth have either been destroyed or disturbed in some way. Much of the site destruction probably occurred during the sheep-ranching period, along with the concurrent adverse effects of pot hunters and vandals. Some of the more recent damage has resulted due to the naval use of the island. It is believed, however, that the military use of the island has generally been beneficial to the cultural resources, since these activities are limited and exclude the general public.

## COORDINATION OF SCIENTIFIC RESEARCH

The uniqueness of San Clemente Island, which on one hand is the focus of conservation and management programs,

Figure 46. A researcher points to vertebrae of a fossil marine mammal.

Figure 47. A layer of shells in a road cut high above the present sea level.

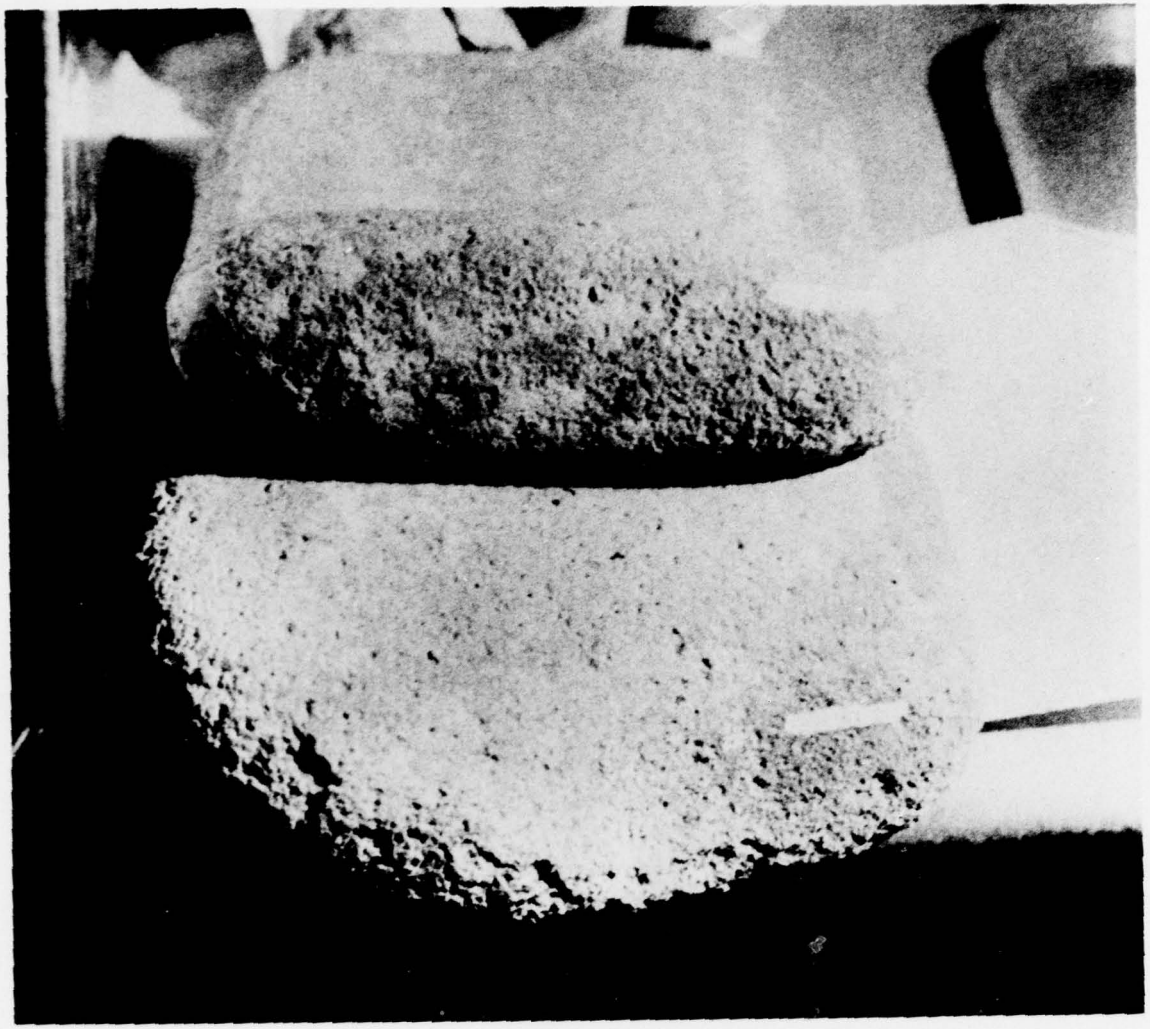

Figure 48. Muller and grinding stone. Artifacts dealing with San Clemente Island's earliest history are on display at San Diego Mesa College.

Figure 49. L. Michael Axford, project archeologist, San Clemente Island Archeological Survey. His work is changing previously held views of Channel Island prehistory, and particularly, San Clemente Island's significance during man's earliest existence there.

Figure 50. Dr. Barry Roth has studied the various species of San Clemente Island snails.

Figure 51. Dr. Charles Hogue, entomologist with the Los Angeles County Museum of Natural History, collecting specimens on San Clemente Island.

Figure 52. Dr. Louis Wheeler, professor of botany at the University of Southern California, studying the relationships between lichens and their substrates. Over one-hundred species are found on the island.

Figure 53. Botanists Martin Piehl and E. R. Blakley, of the Santa Barbara Botanic Garden, on San Clemente Island with specimens.

Figure 54. Botanist Tom Oberbauer and ecologist Roger Wilson engaged in tree coring for age determinations.

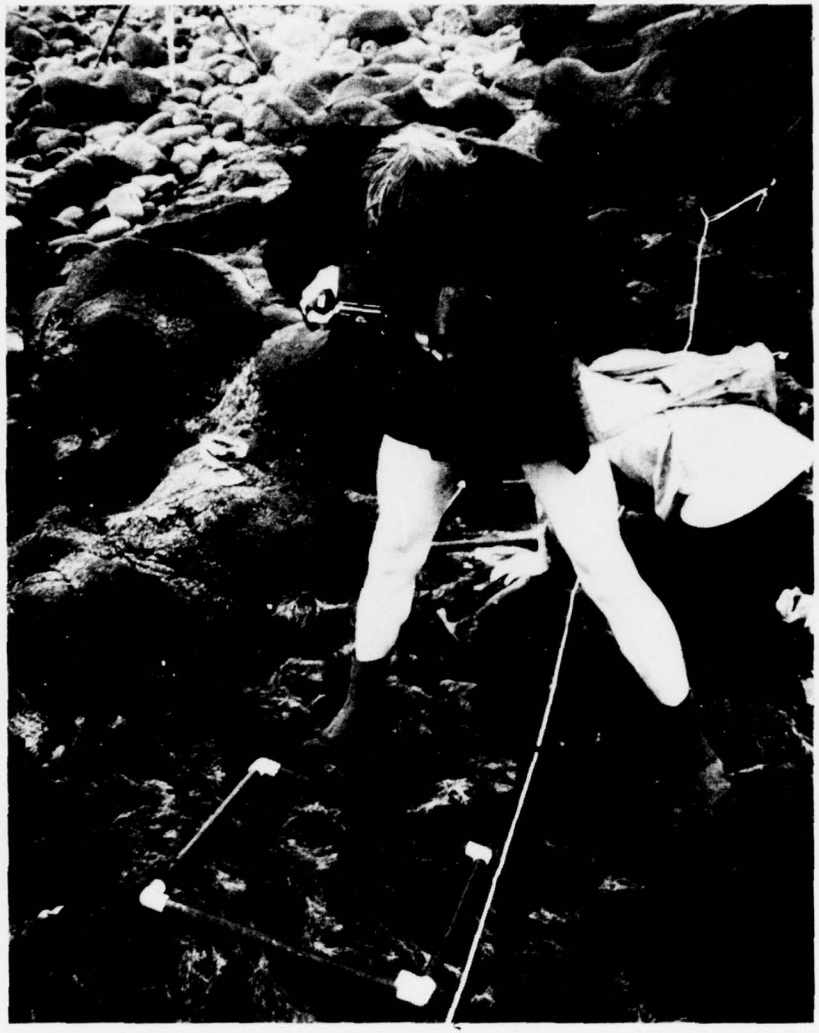

Figure 55. Marine ecologist Robert Cohen studying the intertidal vegetative community.

TABLE 3. SCIENTIFIC RESEARCH ON SAN CLEMENTE ISLAND.

| | 1975 | 1976 | 1977 |
|---|---|---|---|
| Genetic Divergence in Channel Island Mammalian Populations. Dr. Ayesha Gill, University of California, Los Angeles | | | |
| Physiological Responses of the Island Night Lizard. Randall Johnson, University of Kansas | | | |
| Geological Survey of San Clemente Island. Jack Vedder & David Howell, U. S. Geological Survey | | | |
| Channel Islands Marine Mammal Survey. Kenneth Norris (Project Director), University of California, Santa Cruz (BLM Contract) | | | |
| Channel Islands Marine Bird Survey. George Hunt (Project Director), University of California, Irvine (BLM Contract) | | | |
| Evaporative Water Loss in the Island Night Lizard. William Mantz, Cornell University | | | |
| Speciation in Channel Island Crickets. Steven Maskell, University of California, Santa Barbara | | | |
| Channel Islands Rocky Intertidal Survey. Mark Littler (Project Director), University of California, Irvine (BLM Contract) | | | |
| Blood Chemistry of the Island Night Lizard. Andrew Hughes, Fullerton State College | | | |
| Pliocene Strata of San Clemente Island. Carol Stadum & Takeo Suzuki, University of California, Los Angeles | | | |
| Paleontological Survey of San Clemente Island. Lawrence Barnes (Project Director), Los Angeles County Museum of Natural History | | | |
| Channel Islands Sandy Beach Intertidal Survey. Roger Seapy (Project Director) | | | |
| Genetic Divergence of the Isopod Ligia occidentalis. Thomas McGill, University of California, Santa Barbara | | | |
| Vertisol Genesis on San Clemente Island. Daniel Muhs, University of Colorado | | | |
| The Effect of Feral Goats on the Ironwood Tree (Lyonothamus) on San Clemente Island. Duffy Clemons, San Diego State University | | | |
| Allozyme Variation in Populations of Lavatera assurgentiflora. Laurie McKean, Claremont College | | | |

is also of great interest to the academic community. Due to the tremendous diversity of interests directed toward the island, research must be controlled. Research that concerns endangered or threatened species or deals with characteristics unique to the island, that are of direct applicability to the development or maintenance of the Natural Resources Management Plan, and that are of sound scientific merit, are considered for approval.

Since research is often a prerequisite to management, cooperative efforts with the academic community are numerous, of mutual benefit, and produce knowledge new to many different scientific disciplines. To date, the Natural Resources Program has participated with over thirty-five individuals or groups in the pursuit of research goals. Some of the more significant projects – those which have yielded products of use for specific management purposes – include the Bureau of Land Management's outer continental shelf biological survey, the U. S. Geological Survey's reconnaissance of the island, and a Cornell University student's project on the Island Night Lizard.

## CONCLUSION

San Clemente Island is unique, and as such, warrants special attention. Its formation and geologic evolution was basically independent from the remainder of the Channel Islands, and the physical resources it embodies are distinctive. The Island's cultural history, though not yet well understood, appears to be significantly different from the neighboring islands and the coastal mainland. And the biotic community – an impoverished assortment of species – has developed in isolation and under selective regimes not found on the adjacent mainland. Since these resources are fragile, extremely sensitive to interference from outside influences, and of intense interest to the scientific community, they must be managed collectively.

The basic goal of the Natural Resources Management Plan for San Clemente Island is to reestablish, as a whole, the native ecological conditions. The programs outlined herein are directed toward the accomplishment of that goal and are in the best interest of sound and aggressive management of natural resources. With the administrative transfer of San Clemente Island to Naval Air Station North Island, the programs developed and implemented by the Naval Ocean Systems Center will be continued, not only to maintain a problem-oriented stance to natural resources management, but also to ensure public trust in the Navy's awareness of and response to environmental problems.

Figure 56. A most welcome sight – the plant community recovering! This native stand of malva rosa appeared shortly after the removal of deer and goats from the northern end of the island.