

sonorensis

Arizona-Sonora Desert Museum

Sea of Cortez

Winter 2002

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Introduction

The Sea of Cortez is a treasure in our own backyard. Some of the most fascinating stretches of the Sonoran Desert occur in the areas where the "desert meets the sea." Baja and the Gulf of California (another name for the Sea of Cortez) have long been the destination of adventurous tourists and hard-working scientists, often under the auspices of the Desert Museum. In 1964, the efforts of Lew Walker and other Museum staff culminated in the establishment of Isla Raza in the Gulf as a critical sanctuary for migratory waterfowl.

We are pleased to be building upon, and expanding, this legacy of research and education about the Sea of Cortez. Without the Gulf we would not have the summer monsoon rains which are so important in defining our region. The Gulf also provides essential habitat for the migratory birds of the great Pacific Flyway. It is an important economic driver for the region with fishing and tourism industries dependent upon its waters and beaches. Did you know that the ocean surface of the Gulf of California is about the same as the entire land surface of the Sonoran Desert (100,000 square miles)?

Look for the Desert Museum to become increasingly involved in scientific research, education, and conservation activities in the Sea of Cortez in the future. I hope you enjoy this issue of *sonorensis* devoted to this fascinating and important part of the Sonoran Desert region.

Robert Edison
Interim Executive Director

P.S. Let us know if you like the bold new look we are introducing with this issue of *sonorensis*.



J.A. Semmler



R. Branca



R. Branca



On the VERMILION SEA



Beauty and biodiversity may be endangered in the Gulf of California

The Gulf of California has held a growing fascination for naturalists for the past 150 years, though it wasn't until 1940 that modern marine biology entered its waters through the pioneering

expedition of Edward F. Ricketts and John Steinbeck aboard the *Western Flyer*. The biological discoveries of that amazing voyage, chronicled in *The Sea of Cortez: A Leisurely Journal of Travel*

and *Research*, launched an era of Gulf research that continues today. Compared to many of the world's coastlines, however, our knowledge of the Sea of Cortez is still young.

Richard C. Brusca | Director of Conservation & Science | Arizona-Sonora Desert Museum

OCEANOGRAPHY

The Sea of Cortez exceeds 700 miles in length, covers nearly 100 square miles of surface area, and spans over 9 degrees of latitude. It is composed of 3 distinct biogeographic regions: the Northern Gulf extends from the Colorado River delta southward to the Midriff Islands (the largest being the Islas Tiburón and Ángel de la Guarda); the Central Gulf ranges from the Midriff Islands to Guaymas (Sonora) and Punta Coyote (Baja California Sur); and the Southern Gulf extends southward to Cabo Corrientes, Jalisco on the mainland, and Cabo San Lucas on the Baja California Peninsula. The great East Pacific Rise runs right up the center of the Gulf, and continues to push Baja away from mainland Mexico at the rate of several inches per year.

The Northern Gulf offers some of the most powerful tides in the world. The annual tidal range at San Felipe and Puerto Peñasco is about 7 meters, while on the Colorado River delta it is nearly 10 meters. The climate is very dry, with an average annual rainfall of less than 10 centimeters. Most of the Northern Gulf is shallow, less than 100 meters in depth, and because of this—and due also to its location in the heart of the Sonoran Desert—coastal seawater temperatures vary strongly with the seasons, falling to between 8 and 12°C in the winter (equivalent to the southern California shores), but rising to 30°C or more in the summer.

The Central and Southern Gulf maintain more oceanic conditions than the north, with warmer and more stable water temperatures. Rainfall is fairly high, averaging 50 to 100 centimeters per year. Tides in the Southern Gulf have much lower amplitudes than in the Northern Gulf, with maximum annual ranges of 2.3 meters (La Paz) to 2.7 meters (Mazatlán). The

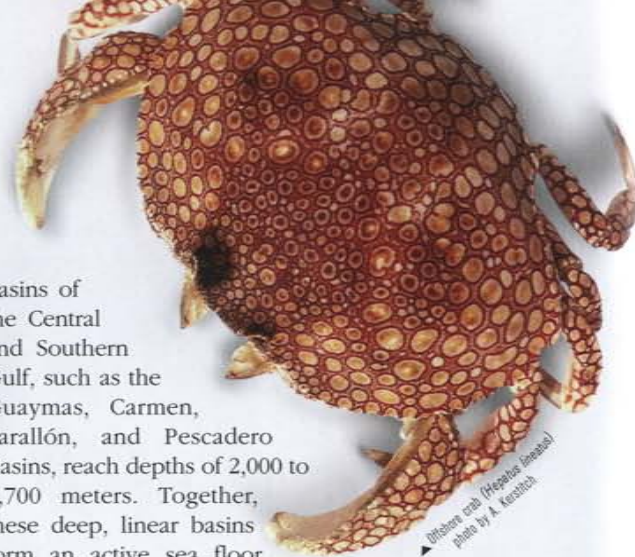
basins of the Central and Southern Gulf, such as the Guaymas, Carmen, Farallón, and Pescadero Basins, reach depths of 2,000 to 3,700 meters. Together, these deep, linear basins form an active sea floor spreading center complete with hydrothermal vents and a unique community of benthic organisms.

At the mouth of the Gulf, the trough formed by this series of basins approaches Cabo Corrientes (Jalisco), the likely site where the Cape Region of Baja California was originally attached to the mainland before being torn away 5 to 10 million years ago. This area, where the Sea of Cortez begins, is a complex mix of surface waters from several sources, including warm saline Gulf waters, cold California current waters, and warm, tropical Eastern Pacific waters. Where these waters of different temperature, salinity, and density meet, hydrographic fronts develop, plankton and other sea life accumulate, and commercial and sport fisheries flourish.

The Gulf of California has exceptionally high rates of phytoplankton growth. In fact, this growth is comparable to that of the greatest fishing areas of the world, and averages three times that of the open Atlantic or Pacific at similar latitudes. The rich, pelagic waters of the Gulf are famous for supporting large numbers of fishes, marine mammals, sea turtles, marine birds—and human fisheries. Forty percent of Mexico's fishery production comes from the Sea of Cortez.



▲ An undescribed jellyfish. This is one of several dozen species of jellyfishes in the Gulf that lack formal names and descriptions.



▲ Dithone crab (*Hepatus sinensis*)
photo by A. Kerstitch

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In the Northern Gulf, nutrient and plankton levels are high year-round and show little variation by season, although in recent years the primary sources of nutrients have probably been agricultural drainage and the release of nutrients trapped in eroding Colorado River sediments. High nutrient levels, shallow waters, and strong tidal mixing combine to make the Northern Gulf one of the most productive marine regions on earth. Large fish and at least 12 species of whales and dolphins, including the critically endangered vaquita porpoise, enjoy these fertile waters.

The Central and Southern Gulf are also highly productive waters, but these regions are largely supplied by cold, nutrient-rich water from the Pacific that enters the Gulf at great depths. These waters are driven to the surface in localized areas, and when they near the surface their nutrients and high oxygen content combine with sunshine to cause phytoplankton blooms, initiating food chains of zooplankton, fish, and ultimately, marine mammals and sea birds.

This process, called “upwelling,” is especially common in the Central Gulf, where seasonal winds blow surface waters away from the coast, and where the basins turn upward and drive their deep currents to the surface. “Red tides,” localized phytoplankton blooms so dense that they discolor the water, occur daily during the spring and summer months in the Central Gulf. These waters are so rich that populations of sperm and finback whales have forsaken their ancestral migratory instinct and taken up permanent residence. Some Pacific Gray whales even enter the Central and Southern Gulf to feed during the winter. During El Niño years, when productivity in most of the Eastern Pacific plummets, the Central Gulf remains a refuge for many species, sustaining their populations until conditions improve elsewhere.

In recognition of its remarkable conditions, Francisco de Ulloa (an explorer under the command

of Hernán Cortés) first named the Gulf of California the “Vermilion Sea.” Ulloa, knowing on which side his bread was buttered, also christened the Gulf “Mar de Cortés,” the name that history has kept on the maps.

B I O D I V E R S I T Y

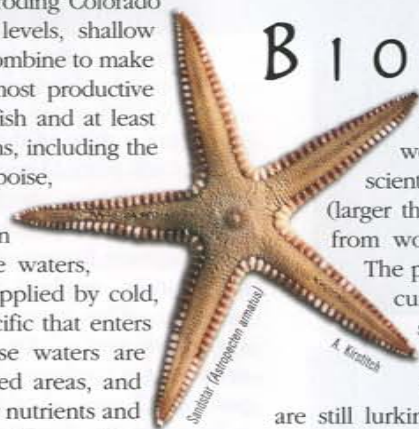
For the past eight years, I have been working with a group of Mexican and U.S. scientists to catalog every known macroscopic (larger than 2 millimeters) species of animal life, from worms to whales, in the Sea of Cortez.

The project, called “Macrofauna Golfo,” has a current tally of nearly 6,000 named species. Of course, this is probably still less than half the actual species count, as many animals yet to be described are still lurking in the rich waters of the Gulf. The cataloged fauna includes 4,857 invertebrates and 1,113 vertebrates (891 fishes; 222 non-fish vertebrates). These numbers rank the Sea of Cortez among the most diverse marine regions on Earth.

The flora and fauna that inhabit the Gulf comprise a rich mix of life derived from an array of sources: from tropical Central and South America, from the Caribbean Sea (before the uplift of Panama sealed the Caribbean-Pacific Seaway 3 to 4 million years ago), from the temperate shores of California (during past glacial periods, when coastal waters were cooler), and even across the vast stretch of the Pacific Ocean from the tropical Indo-West Pacific.

1,432 species inhabit the Upper Gulf and the Colorado River Delta Biosphere Reserve (see page 9), which adds up to 24 percent of the Gulf's total. One of the richest areas in the entire Gulf is Pulmo Reef (near La Paz), the only true coral reef in the Sea of Cortez. Other regions with notably high diversity include Cabo San Lucas, Bahía Banderas, the limited beachrock habitats of the upper Gulf, the oceanic shelf waters of Sinaloa, and all of the Gulf

▼ The Gulf sea pen (*Ptilosarcus undulatus*) is actually a colony of thousands of miniature polyps.





▲ The Gulf cleaner shrimp (*Lysmata californica*) sets up "cleaning stations" over large rocks. Fish passing by the "station" stop by to be cleaned (picked free of parasites and other skin debris) by the shrimp.



▲ Baby brown pelicans on Isla San Pedro Martir.

islands. Coastal lagoons are also notably diverse areas, and their habitats provide important nursery and feeding grounds for the young of many fishes and shellfish, including most commercial finfish and shrimp.

Of the 891 fishes recorded in the Gulf, 801 are bony fishes (Actinopterygii) and 90 are cartilaginous fishes (Chondrichthyes). Nearly 10 percent of the Gulf's fish fauna (87 species) is endemic, occurring nowhere else in the world. The Gulf's non-fish vertebrate fauna includes 181 sea birds, 34 marine mammals, and 7 marine reptiles.

Two aquatic bird species are essentially endemic to the Gulf, the Yellow-footed Gull and Craveri's Murrelet. These birds, as well as the Least Storm Petrel, Heerman's Gull, and Elegant Tern, rely almost wholly

on the Gulf for reproduction—90 percent of their breeding populations are found in the Gulf, mostly on a few small islands. In

the case of the Heerman's Gull and Elegant Tern, 95 percent of their breeding population

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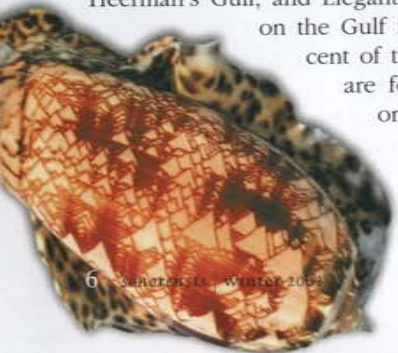
occurs on a single island, Isla Rasa, which is only a square kilometer in size. The Biosphere Reserve is further home to an extraordinary avian diversity of 131 species.

The marine mammal fauna of the Gulf is also astonishingly diverse, with 29 cetaceans (whales, dolphins, porpoises), 4 pinnipeds (sea lions, seals), and one bat (the endemic coastal fishing bat, *Myotis vivesi*).

More than a third of the world's cetacean species occur in the Gulf, with 22 species of the Odontoceti (toothed whales, dolphins, porpoises) and 7 species of the Mysticeti (baleen whales). One of the cetaceans found in the Biosphere Reserve is the vaquita (*Phocoena sinus*), the world's smallest and most endangered marine cetacean. This rare porpoise is endemic to the uppermost part of the Gulf, where its critical habitat straddles the southern boundary of the Reserve. In all, 38 percent (13 species) of the Gulf's marine mammal fauna is found in the Biosphere Reserve, a testimony to the importance of conservation efforts in this area.

The 7 marine reptiles found in the Gulf include small populations of 5 sea turtles, a sea snake (*Pelamis platurus*), and a crocodile (*Crocodylus acutus*). Four of the turtles inhabit the Biosphere Reserve, and all are threatened or endangered due to historic—and now modern—fishing pressure. Crocodiles are present only in a few estuaries of the mainland side of the Southern Gulf. The yellowbelly sea snake (a tropical Indo-Pacific species) may be seen infrequently in the Central and Northern Gulf, but is increasingly common southward all the way to Ecuador.

There are a whopping 4,857 named species of invertebrates recorded in the Gulf, and 769 of these (16 percent) are endemic to the Sea of Cortez. The Biosphere Reserve is home to 1,053 species of invertebrates, or 22 percent of all those known in the Gulf. At the phylum-level, the highest species diversity occurs with the Mollusca (2,193 species) and Arthropoda (1,051 species). Over 1,530 species of snails (gastropods) alone have been reported in the Gulf.



◀ Gulf text olive (*Oliva porphyria*) - photo by A. Kerstitch

THE COLORADO RIVER



◀ Gulf sunstar (*Heliaster kubiniji*) - photo by R. Brusca

The single most serious threat to the integrity of the delta's natural communities is probably Colorado River water management decisions made by U.S. politicians. Virtually all of the rivers that once reached the Gulf have been altered or destroyed by overdraft and diversion (including the Ríos Fuerte, Mayo, Yaquí, and Sonora), but the most significant is the Colorado River. Historically, more than 15 million acre-feet of Colorado River water reached the delta annually. Before the completion of Hoover Dam in 1935, fresh water from the Colorado River flowed into the Gulf throughout the year, with great seasonal floods resulting from spring snowmelt in the Rocky Mountains. By the time Glen Canyon Dam was completed in 1962, the flow of Colorado River water arriving at the Gulf had completely ceased. For 20 years after completion of Glen Canyon Dam, as Lake Powell filled, virtually no river water at all reached the sea.

Twenty dams and thousands of kilometers of canals have converted the once-mighty river to a highly controlled plumbing system, and every drop of water is measured, managed, and fought over, with only a dribble reaching the delta. Today, less than 10 percent of the delta's formerly magnificent wetlands remain. Due to the greatly reduced freshwater flow, the powerful tides of this region now overwhelm the delta and river channel. During spring tides, seawater rushes 50 to 60 kilometers upriver, a marine intrusion which has killed

most of the freshwater flora and fauna that used to live along the lower river corridor.

Prior to the construction of Hoover Dam, the annual sediment discharge from the Colorado River into the Gulf was also enormous, estimated to have ranged from 50 to 450 million metric tons a year. Indeed, the entire Northern Gulf is considered the "Colorado River Sedimentary Province." The reduction of sediment discharge, along with freshwater, since 1935 has greatly modified the delta and the Northern Gulf. Rather than receiving sediment, the entire delta is now eroding away due to the forces of tides and storms, exposing ancient river sediments and gradually exporting them out of the Northern Gulf.

▼ Close up of the Gulf sea pen (*Phyllocarpus undulatus*)



*The entire delta
is now eroding away due to the
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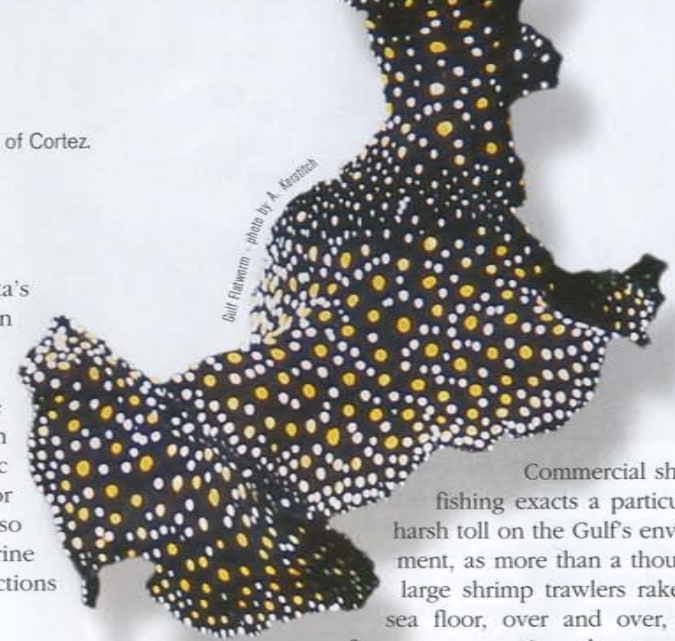
◀ This yellow & red sea fan (*Eugorgia aurantica*) is one of about 20 sea fans known from the Sea of Cortez.

Water has only reached the delta's riparian corridor in recent years when infrequent U.S. flood releases have exceeded the upstream use and diversion capacity. It is likely that the loss of freshwater in the Northern Gulf, in combination with other anthropogenic factors, has driven some species to (or nearly to) extinction. However, we have so little historical or baseline data for marine organisms of this region that most extinctions would go unnoticed.

OTHER DANGERS

Human development has greatly reduced the rich lagoon and mangrove communities of the Gulf, which are the critical spawning and nursery grounds for shrimp and other invertebrate and fish species. Migratory birds rely heavily on the rapidly disappearing coastal wetlands along this western flyway. In the Northern Gulf, reduction of the brackish estuarine habitat, in combination with overfishing, has driven the large, corvina-like totoaba to near-extinction. Commercial shrimp catches have been falling since the 1960s, due to a combination of overfishing and loss of habitat. The young of these shrimp utilize the shallow wetlands of the region, including the tidelands of the delta, as a nursery, migrating into these areas subsequent to their offshore planktonic larval phase. When the shrimp reach a juvenile or subadult stage, they migrate offshore once again.

Today, every fishery in the Gulf is probably overfished. Commercial trawlers drag nets through the water and across the bottom, set long-lines, and use floating gill nets. Small boat (*panga*) fishers often take shrimp and finfish from coastal lagoons throughout the Gulf before they have even reached reproductive maturity.



Bull fisher net - photo by A. Kuznetsov

Commercial shrimp fishing exacts a particularly harsh toll on the Gulf's environment, as more than a thousand large shrimp trawlers rake the sea floor, over and over, year after year, scraping the top few inches of life off the bottom and into their nets. This damages fragile benthic habitats and displaces 10 to 30 kilograms of bycatch for each kilogram of shrimp, depending on the location and time of year. Almost all of the bycatch is discarded. Bottom areas chronically disturbed by shrimp trawlers and the accumulation of their discarded bycatch on the sea floor experience hypoxia (depleted oxygen levels) or even anoxia (too little oxygen for "normal" life). Profound changes in

Vaquita, living only in the northernmost area of the Gulf, are one of the species most endangered by fishing.

ocean-bottom community structure appear to have taken place over the past five decades as a result of this disturbance, bringing about a decrease in the diversity and biomass of benthic life. Where bottom-

fishers used to capture hundreds of species in each trawl, today's catch is dominated by a handful of scavengers, such as skates and blue crabs.

Vaquita, living only in the northernmost area of the Gulf, are one of the species most endangered by fishing. With the most recent estimate of population size at only 567 individuals, and the fisheries' bycatch mortality at an estimated 39 to 84 deaths per year, the chances for this porpoise's survival are low. Incidental capture in gillnets is the vaquita's primary cause of death, and unless this type of fishing gear is banned in the Biosphere Reserve and critical habitat to the south, the vaquita will soon be extinct.

Many once-abundant but less visible species, such as the threatened giant brown sea cucumber (*Parastichopus fuscus*), are now practically gone from the Gulf. Sea cucumbers have vanished at the hands of Mexican and Japanese fishers who collect them for Asian food markets. Visitors from other places hand-collect these and other marine animals, and trample the fragile habitats exposed at low tide, while locals collect larger animals for sale as curios. In areas of heavy tourism, such as Puerto Peñasco, San Felipe, San Carlos, Mazatlán, and La Paz, littoral biodiversity is but a shadow of what it was just 20 years ago.

THE FUTURE

Despite these threats, there are still many coastal refugia (areas not easily accessible by road or large fishing boats) in the Sea of Cortez, which serve as important shelters for species extirpated elsewhere in the Gulf. Meanwhile, numerous Mexican, U.S., and European environmental organizations are increasing their conservation efforts. The Mexican government is tightening their fishing laws. In light of these hopeful signs, it seems almost certain that the 21st century will be one in which the rich biodiversity of the Sea of Cortez will begin to receive the protection it needs. **S**



Commercial shrimp
(*Farfantepenaeus californiensis*)
photo by M. Wicksten

◀ Shrimp boats, Puerto Peñasco
photo by R. Brusca



By the late 1980s there was widespread recognition that the Northern Gulf was experiencing an economic and ecological crisis, leading to a series of workshops. In 1992, a group of environmental nonprofits and government agencies submitted a proposal to the Government of Mexico to declare the Upper Gulf of California and the Colorado River Delta a national (Mexican) biosphere reserve. The national fisheries institute of Mexico fought the reserve idea, fearing its economic impact on Northern Gulf fisheries. However, aware of the extraordinary biological and cultural importance of the Upper Gulf and Colorado Delta ecosystems, and under increased international pressure to protect the endangered vaquita and totoaba, the Mexican Government declared this region a 2,336,890-acre Biosphere Reserve in 1993. 412,000 acres of this reserve is in the Zona Núcleo (Core Zone). Except for traditional

practices by the Cucapá people living in the delta, and clam harvesting by local residents, all commercial fisheries were prohibited within the Core Zone, and regulations increased for most fisheries within the buffer zone (Zona de Amortiguamiento). In 1995, the Reserve was accepted into UNESCO's system of worldwide biosphere reserves. The Upper Gulf/Delta Biosphere Reserve has an official "sister reserve" on the Colorado River in the U.S., the Imperial National Wildlife Refuge (U.S. Forest Service). This partnership has proven highly useful in coordinating efforts at protecting wildlife, especially migratory waterfowl. Although the flora and fauna of the Northern Gulf is fairly well known, the biota of the Biosphere Reserve and delta region are largely unexplored. Fundamental biological exploration remains to be made along the coastline in the uppermost Gulf and within the delta itself.

TWENTY



L.W. Wilson

Dra. Enriqueta Velarde

CENTRO DE ECOLOGÍA Y PESQUERÍAS
UNIVERSIDAD VERACRUZANA



THOUSAND LEAGUES

A SEABIRD'S VIEW OF THE SEA OF CORTEZ

To the casual human observer sailing over the sea, the water's unending surface may seem monotonous. To ocean enthusiasts, fishermen, and marine animals such as seabirds, whales, dolphins, and fish, however, the ocean is a fascinating three-dimensional space that has inspired a thousand tales, from Jules Verne's *Twenty Thousand Leagues Under the Sea* to Sebastian Junger's *The Perfect Storm*.

photography by Sue Adams

UNLESS OTHERWISE NOTED



THE SERI PEOPLE CALL

THESE MINUTE

SEABIRDS



Elegant Terns

“THE ONES WHO BOUNCE

ON THE OCEAN,”

BECAUSE OF THE WAY THEY MOVE

OVER THE
WATER’S SURFACE.

In this realm of mystery, the Gulf of California is no exception. It is an extraordinarily diverse sea, whose biological richness and complex underwater topography represent an array of marine environments worldwide. With a broad range of habitats, including estuaries and mangrove swamps, temperate and tropical oceanic habitats, underwater prairies of eelgrass, rock and coral reefs, shallow sandy bays, and the remnants of the once-vast Colorado River delta, it is no surprise to find that a wide variety of prey species inhabit this area, which in turn attracts a rich array of seabird life.

The diversity of species and habitats in the Sea of Cortez may be largely due to the oceanwater masses that are continuously moving and changing over space and time, creating a multitude of microhabitats for seabirds and other marine animals. "Fronts," which in certain satellite images look like rivers on the ocean's surface, often separate cold, productive, nutrient-rich waters from warm, low salinity, less nutrient-rich waters. Plankton flourish in frontal zones, attracting storm-petrels and other plankton feeders. Storm-petrels feed on the rich plankton using a unique method called "filtering," whereby the tiny organisms are filtered through specialized beak structures. So when you sail along the Gulf of California, you can observe these small, dark, mysterious figures fluttering along the front boundaries, feeding on the rich plankton produced in these areas. The Seri people call these minute seabirds "the ones who bounce on the ocean," because of the way they move over the water's surface.

In addition to frontal zones, the Gulf's waters are unique for their frequent upwellings, the phenomenon in which nutrient-rich waters rise from the deep to replace less productive coastal waters. Upwellings are part of a complex interaction between water flow, wind, coastal topography (such as capes and canyons), and bathymetry (underwater topography). They are common in the Sea of Cortez due to the narrow size of the Gulf and the many islands that divert and funnel the twice-daily tidal surges in and out of this basin.



THE GULF OF CALIFORNIA

IS A PLACE WHERE

YOU CAN FIND **SEABIRDS**

FROM DIVERSE ORIGINS AND

GEOGRAPHIC AFFINITIES.





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Migratory pelagic stocks of sardine, anchovy, mackerel, rockfish, and hake dominate areas of upwelling, and the perpetually changing oceanographic conditions affect the distribution, abundance, survival, and reproduction of these fish species as well as other important seabird prey. The churning of the water by island-obstacles, particularly in the Midriff Island area, also prevents mild El Niño events (characterized by low marine productivity) from severely impacting the ecosystem. In this way, the Midriff Island Region acts as a natural refuge during times of stress for many marine species.

The Gulf of California is a place where you can find seabirds from diverse origins and geographic affinities. The closest relatives of the two most common gulls (Yellow-footed and Heermann's) are found in the Humboldt Current off the west coast of South America, while the two common cormorant species (Double-crested and Brandt's) are believed to have originated in North American temperate waters. Other cold water species such as Black and Least Storm-petrels and Black-vented, Pink-footed, and Sooty Shearwaters are more at home in the cooler offshore waters. These

species are never observed close to the coast or even in close proximity to the islands. In contrast, Brown Pelicans, Brown and Blue-footed Boobies, and Tropicbirds prefer more tropical waters and depend on land for loafing, roosting, and nesting. Western Grebes, phalaropes, and loons migrate south from northern latitudes for the winter. Magnificent Frigatebirds, Masked and Red-footed Boobies, and other gull and tern species that occupy the southern portion of the Gulf inhabit mangrove swamps and estuarine habitats. This vast array of species is complemented by a large



THE CHURNING OF THE WATER BY ISLAND-OBSTACLES,
PARTICULARLY IN THE MIDRIFF ISLAND AREA,
ALSO PREVENTS MILD **EL NIÑO** EVENTS FROM
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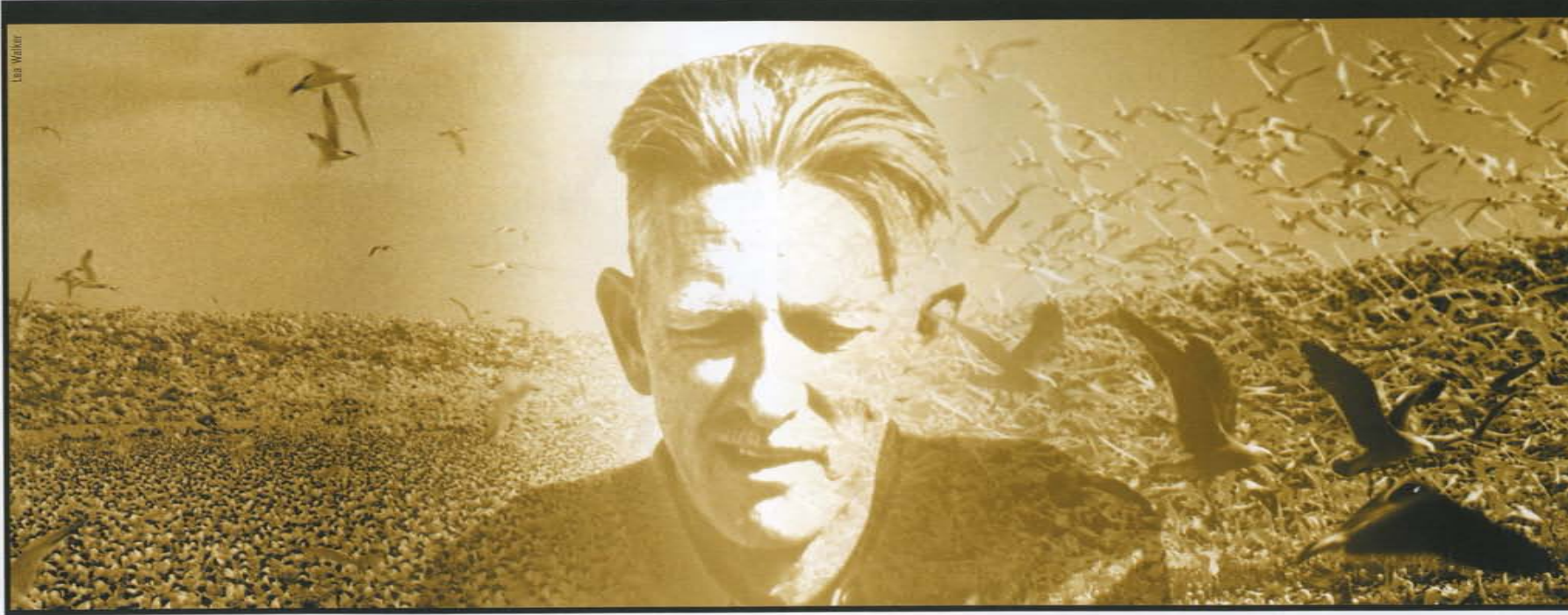


variety of waders, shorebirds, and waterfowl that use the coastal and eelgrass-rich waters of the gulf.

Just as the prey species and habitats in the Gulf vary widely, so too do the feeding methods and diets of these birds, a circumstance which has allowed many closely related species to coexist with little or no competition. Some similar species such as Elegant and Royal Terns feed in very different habitats and on distinct diets, the first being a pelagic feeder and the second a coastal feeder. Elegant Terns and Heermann's Gulls are close relatives that both feed on small pelagic fish such as sardines, anchovies, and mackerel, but the tern is an aerial plunge diver, while the gull is a surface plunger who may also steal fish from terns and Brown Pelicans. Pelicans and Blue-footed and Brown Boobies are deep plunge divers, while their relatives, the Double-crested and Brandt Cormorants are surface divers that pursue their large prey underwater, propelling themselves with webbed feet. Craveri's Murrelets and Eared Grebes pursue small fish in this same manner. The

Yellow-footed Gull, which is not found anywhere else in the world, may surface plunge, scavenge, prey on small seabirds such as Black and Least Storm-petrels and Eared Grebes, feed on mollusks, steal other seabirds' eggs or chicks, or feed on refuse. This gull is the Gulf of California's most eclectic seabird feeder.

Until the late 19th century, humans had a relatively small impact on seabird life in the Gulf. However, increased human activities, including seabird egg collection, guano harvesting, fishing, introduction of exotic species, coastal shrimp farming, pollution, and unregulated tourism, have taken their toll on bird populations. Some of these activities have ceased since the islands of the Gulf of California were declared protected by the Mexican government. However, fishing and tourism continue at a growing pace, though if properly managed, they could have minimal impacts or even be beneficial activities. This is our challenge, in order to preserve this remarkably diverse and unique ocean ecosystem for future generations. **S**



Len Wilbur



Saving the Birds of Isla Rasa

HOW ONE MAN BEGAN A MOVEMENT

TO PROTECT ISLAND WATERFOWL

PEGGY LARSON

ARCHIVIST

ARIZONA-SONORA DESERT MUSEUM

ONE OF THE WORLD'S DENSEST AVIAN NESTING POPULATIONS, LOCATED APPROXIMATELY 400 MILES SOUTH OF THE HEAD OF THE SEA OF CORTEZ, WOULD HAVE BEEN IRREPARABLY LOST IN THE 1960S IF NOT FOR A SMALL GROUP OF U. S. AND MEXICAN CONSERVATIONISTS, ONE CONCERNED BENEFACTOR, AND THE PRESIDENT OF MEXICO. THE MAN WHO BROUGHT THESE PEOPLE TOGETHER, WHO ORIGINALLY RECOGNIZED THE THREAT TO THE BIRDS, PUBLICIZED IT, AND BEGAN THE MOVEMENT THAT WOULD RESULT IN THE CREATION OF THE ISLA RASA MIGRATORY WATERFOWL SANCTUARY, WAS LEWIS WAYNE WALKER, ORNITHOLOGIST, PHOTOGRAPHER, AUTHOR, AND ASSOCIATE DIRECTOR OF THE ARIZONA-SONORA DESERT MUSEUM FROM 1954 THROUGH 1970.



Lew Walker, shown here on one of the Gulf islands examining an octopus, was an authority on the biota of the Sea of Cortez and its islands.

Isla Rasa is less than a square mile in extent and at its highest point not quite 100 feet above sea level. Yet it is the primary nesting area for both Royal and Elegant Terns, and the main breeding location for the Heermann's Gull. It is estimated that Gulf of California islands, primarily Isla Rasa, provide nesting habitat for 90 percent of the North American populations of these three species.

Each year, Heermann's Gulls migrate from California's coast and from as far south as Panama to reach Isla Rasa by April 1st. They arrive in dense flocks, pick out their tiny plots, and almost immediately lay eggs, covering the valleys' floors with incubating gulls.

About ten days later Elegant and Royal Terns arrive from the California coast and Central and South America to linger in the tidal lagoons and watch the number of migrants increase day by day. When the birds grow restless, flocks of thousands rise, swoop low over the valleys, and return screaming to the lagoons.

Without fail, a night comes when a tern flock numbering thousands of individuals descends on land claimed by the gulls. Through sheer numbers they dispossess the gulls and start laying their own eggs. At dawn the terns control a plot perhaps 50 feet in diameter, with evicted gulls circling and robbing any unprotected tern eggs on the periphery. The tern colony shrinks under such intense predation, but with darkness additional terns arrive on the island and their numbers expand.

The tern population continues to fluctuate in size. By the time the migration trickles off, the first eggs laid—now protected in the center of an acre or two of terns—begin to hatch. The precocious young band together, move through a maze of incubating eggs, and hide in the rocks where they are miraculously found and cared for by their parents. The center of the tern colony, now hollow, is invaded by predaceous gulls and the cycle continues.

A NEW ARRIVAL

Lewis Walker began exploring Baja California and the Sea of Cortez in the late 1930s. At that time, roads in Baja were dirt tracks and the waters of the Gulf little known except by Mexican fishermen. Walker wrote of one of his earliest trips in the Gulf, "We went for seven weeks without seeing another boat."

He first visited Isla Rasa in 1946. In the Bahia de Los Angeles he hired a boat, "homemade from flotsam of the Gulf," and its turtle-fishing owners to take him to Isla Rasa. The boat, powered by currents, oars, and a sail full of holes, arrived at the island a day and a half later. The masses of birds Walker found on Isla Rasa thrilled him, and upon his return to the U.S. he sold an article and photographs, "Sea Birds of Isla Raza," to National Geographic. In 1947 he returned to the island, but to his amazement found very few nesting birds. Their absence was a puzzle, but Walker found an ominous clue: "Human footprints were plainly evident where they had not been erased by the winds."



Tiny Isla Rasa, less than a square mile in extent, is the major nesting area for both Royal and Elegant Terns, thousands of which migrate there to breed each spring.

The footprints were later explained when Walker met a Mexican fisherman who reported that motorboats had visited Isla Rasa earlier that year and removed thousands of eggs to be sold for food in Santa Rosalia and other ports. There had been some minor egg harvesting in other years, but as transportation became easier and markets grew, the eggers had increased in number. Men invaded the island during the nesting season, relentlessly sweeping up the eggs and testing them in buckets of salt water. Eggs that floated were partially incubated and thrown away. Those that sank were considered fresh and were carefully packed to be sold for food in nearby ports.

As Walker returned to Isla Rasa year after year, he documented the astounding decrease in the bird population, sinking numbers which were, he found, in direct ratio to the increase in human marauders. There were years when reproduction, which should have been close to a million, was cut to several thousand. It seemed that Isla Rasa's days were numbered.

Walker shifted into high gear. Dr. Joseph Wood Krutch, a Desert Museum Trustee, was a good friend of Walker's, and Krutch in turn had been in correspondence with a San Francisco industrialist and Board

A LITTLE DISCUSSION REVEALED THAT THE EGGERS

EXPECTED TO TAKE APPROXIMATELY 400,000

EGGS FROM THE ISLAND THAT YEAR.

member of the California Academy of Sciences, Kenneth Bechtel. When Bechtel heard Walker's story, he took Krutch, Walker, Arizona-Sonora Desert Museum Director William H. Woodin, and others by plane to Baja California, where the group began to study the need for research and conservation. They returned numerous times, and Bechtel established the Belvedere Scientific Fund with Krutch, Walker, Woodin, and other well-known scientists named to the board.

Meanwhile, Walker sought the help of several high-profile scientists of the day, including Roger Tory Peterson, renowned ornithologist, author, artist, and an administrator with the National Audubon Society, Dr. George Lindsay of the California Academy of Sciences, and Carl Buchheister, President of the National Audubon Society. In 1961 Peterson, Krutch, Walker, and Mervin Larson from ASDM spent a week on the island producing a film, which they distributed widely. They further brought the desperate need for protection of the birds of Isla Rasa to the attention of Mexican scientists in positions of authority.

In 1964 the deteriorating situation on Isla Rasa was made impressively apparent when Carl Buchheister, under the auspices of the Belvedere Scientific Fund, surveyed the Isla Rasa bird population. In April he found 21 men encamped on the island with 7 boats anchored nearby. A little discussion revealed that the eggers expected to take approximately 400,000 eggs from the island that year. Buchheister wrote, "In short, these men were removing all

eggs as fast as they were being laid, and from the entire island." Not a single chick was to be found. He called it "one of the most shocking acts of human predation on wildlife that I have ever witnessed." Buchheister returned in June and found that some of the terns had been able to nest a second time with limited reproduction, but he estimated that the Heermann's gulls' nesting and reproduction for that season was a 99 percent failure!

The conservation interests of the National Audubon Society turned to the tiny island. The Belvedere Scientific Fund sponsored scientific expeditions to the Gulf, and provided funds for biological investigation, and later, for enforcement of protective regulations. The Arizona-Sonora Desert Museum actively supported the conservation efforts. In Mexico Dr. Enrique Beltran, Subsecretary of Forestry and Game, and Dr. Rodolfo Hernandez Corzo, Director General of Wildlife, became personally and professionally involved in the project. At last, on May 30, 1964, President Lopez Mateos signed a decree which named Isla Rasa a Migratory Waterfowl Reserve, a move that ultimately led President Jose Lopez Portillo to decree in August 1974 that all of the Gulf islands were to have similar protection, their plants and animals to remain undisturbed. The resulting reserve is the "Islas del Golfo de California Area de Proteccion de Flora y Fauna."

Today Isla Rasa is accessible only to researchers. On the island, the Heermann's Gulls and terns are flourishing. Egg collecting has stopped and scientific knowledge regarding the birds has greatly increased due to the

studies of Dr. Enriqueta Velarde. This amazing scientist first visited Rasa in 1979 and has since returned to live on the island for two months each year during the birds' nesting season. She and additional scientists have studied the breeding and feeding ecology of the gulls and terns, and conducted population censuses and banding programs. With assistance from the Universidad Nacional Autonoma de Mexico, two rodent species, black rats and house mice, originally introduced through guano recovery operations on Rasa, have been eradicated from the island, resulting in an increase in the breeding success of the birds. Velarde's studies of the nesting seabird populations have allowed the development of models which are able to predict the sardine fishery in the area one year in advance.

Ana Luisa Figueroa is director of the reserve under the Mexican agency similar to our Department of the Interior. Under Figueroa's direction, planning is underway to establish a nature center at Kino Bay, which will focus on the Gulf Island Reserve. ASDM is helping develop this new center; Dr. Richard C. Brusca, the Museums' Director of Conservation and Science, serves on the Advisory Board for the project.

Certainly Lew Walker's early efforts to save the birds of Isla Rasa have borne rich rewards for the Gulf islands. After his death in 1971, Lew's wife, Melanie, stated, "Lew's proudest achievement was the role he played in the creation of this sanctuary." In accord with Lew's wishes, his ashes were scattered over Isla Rasa. **S**




The small boat that took Lew Walker to Isla Rasa on his first visit in 1946.



Jewels
DESERT *of the* OCEAN

THE CHARISMATIC SEA TURTLE STILL SPARKLES IN THE GULF OF CALIFORNIA



It was a warm October morning, and lying before me was my first sea turtle in the wild. I had often wondered what this event would be like. Though I had seen these majestic creatures in captivity, I believed that an encounter in nature would be completely different—and it was. But, rather than being euphoric, it was a poignant moment. The black sea turtle lay dead at my feet. Green monofilament formed a plastic web that encased its charcoal-colored shell. Its eyes and other soft tissues had already become host to a series of invertebrate consumers and decomposers. The smell of death hung in the air. This animal was a victim of “incidental catch,” wherein fishermen and shrimpers that choose not to use Turtle Exclusion Devices accidentally capture—and kill—a variety of sea turtles. Though I had read of such tragedies, witnessing it first hand registered greater impact and wouldn't allow me the detached perspective that books make possible.

According to evolutionary theory, multicellular life evolved in the sea before moving onto land. Such is the case for reptiles, whose physiology and morphology are well adapted for terrestrial existence, especially in warm, dry places. Not surprisingly, almost all of the 103 reptile species found in the Gulf of California are desert dwellers, while 44 percent are island endemics. However, seven reptile species, five of which are turtles, have returned to the sea and adopted a marine existence.

Most residents of the Sonoran Desert are familiar with box turtles and the high-domed shells of tortoises. Bony armor sheathed in keratin is a turtle trademark. This body shape has served them well on land, but when

it comes to getting around quickly and efficiently, water is the way to go. A hard shell is a marvelous deterrent to predators, but it has enormous energy costs for landlubbers. Slipping into an aquatic environment allows turtles to move around more easily and cheaply, and permits them to grow much larger. Take for instance the mammoth leatherback (*Dermochelys coriacea*), weighing in at 1,600-plus pounds and up to 8 feet in length. On the other hand, while movement may be easier for sea turtles, their environment has presented them with an array of different challenges. Turtle biology needed a number of adjustments before sea turtles could emerge from the land-bound shadows of their fellows.

Sea Turtle Design: BEAUTY (WITH) A PURPOSE

In architectural design, a debate often ensues over which will drive a project—form or function. In nature they are virtually the same thing. Function is generally paramount, and influenced by natural selection, yet it has created products of unparalleled beauty. Witness the streamlined symmetry of a loggerhead's (*Caretta caretta*) teardrop-shaped shell and the sleek carving of its elephantine appendages which, like paired oars, propel the animal effortlessly through the water. Notice the subtle hues in the scutes of a hawksbill (*Eretmochelys imbricata*), poorly mimicked by manufactured "tortoise shell" products. These sea turtle attributes are

not just ornaments, nor are they accidental. Each has been honed by time to serve the sea turtle's needs.

Reptiles are often inaccurately referred to as cold-blooded, but they are actually poikilothermic ectotherms, which is a better way of describing animals that exhibit variable body temperatures derived from the environment. On land, reptiles are limited to a narrow range of body temperatures—those of the landscape where they live. This might have been problematic at sea, where water temperatures are often unsuitable. Yet active leatherbacks with body temperatures of 24°C have been found along the coast of Newfoundland, where the water temperature hovered around a chilly 6°C! This species pushes the thermal envelope through elevated metabolism, changes in blood flow, and gigantothermy, a term that describes reptiles with large bodies and thick insulation. Gigantothermy allows these animals to maintain constant, relatively high body temperatures even in the face of dramatic variation in their environment.

As if the variation in temperature wasn't enough, sea turtles must further cope with a lack of fresh water.

Deep in a sea turtle's skull is an

enlarged salt gland (up to twice the mass of the brain) which removes excess salt and, by doing so, manufactures fresh water for the animal. This gland enables sea turtles to discharge tears with a salt concentration double that of seawater, which is greater than even most marine birds achieve.

As truly aquatic beasts, sea turtles migrate great distances between nesting beaches and feeding grounds, and have developed the ability to dive deep in the ocean, often staying underwater for prolonged periods. Though most recaptures of the Pacific ridley (*Lepidochelys olivacea*) have been within 200 kilometers of their nesting beach, one turtle was recorded moving 1,900 kilometers in 23 days, with a speed of 82 kilometers per day against the current. The leatherback also travels great distances and has been discovered at depths greater than 1,000 meters. The hawksbill has the longest average dive time of fifty-six minutes. Though not found in the Sonoran Desert, a Kemp's ridley (*Lepidochelys kempii*) has the longest active dive recorded, after remaining submerged for five hours.

In spite of their marine nature, sea turtles must lay eggs on land because their clutches of 50 to 200 eggs would suffocate underwater. Many female sea turtles return to lay eggs on the very beach that they hatched on, and their abilities to find these places are legendary.

Upon emerging from the nest, hatchlings must quickly get to water to avoid hypothermia and a myriad of terrestrial and aerial predators.

moving toward the brighter, lower oceanic horizon, and away from the shadowy silhouettes of shoreline vegetation. Once in the water, hatchlings use waves as a directional cue and unerringly head away from the shore. Eventually they begin to rely on an internal magnetic compass, which enables them to maintain a heading long after land is lost from sight, and when wave directions become inconsistent and confusing.

UPON EMERGING
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Then AND NOW

The earliest marine turtles appeared in the Cretaceous period, best known as the last epoch of the dinosaurs, which were the ruling reptiles of the time. Since the demise of dinosaurs, 31 genera of sea turtles have navigated the planet. Today only 6 genera and 7 species remain. In the tropics, several have broad distributions, yet all are at risk of extinction and most are considered threatened or endangered.

Knowing how to protect sea turtles requires a detailed study of each species, which is why scientists like Dr. Jeffrey Seminoff have spent years studying small populations of the black sea turtle (*Chelonia mydas agassizi*), a subspecies of the green turtle, in and around the Gulf of California. Dr. Seminoff and his collaborators have examined the structure, diet, diving behavior, movement, and habitat use of the black sea turtle population. Their studies, ongoing since 1995, show that the size of adult turtles ranges from 38 to 86 centimeters and, surprisingly, only a small proportion of these are adult males. Dr. Seminoff and Wallace Nichols are finding

MANY FEMALE SEA TURTLES
RETURN TO LAY EGGS ON THE
VERY BEACH THAT THEY HATCHED ON,
AND THEIR ABILITIES TO FIND
THESE PLACES ARE LEGENDARY.



Nesting black turtle at Colola, Michoacan, Mexico.

that turtles captured near the Bahía de los Angeles feed primarily on red algae along with invertebrates such as sponge, soft corals, sabellid worms, and sea pens. However, in the coastal lagoons of the Pacific coast of the Baja Peninsula (also in the Infiernillo Channel of the Gulf), turtles feed almost exclusively on eelgrass. This variability in black sea turtle diet was formerly unknown.

Seminoff and Nichols have also documented, through telemetry data gained from radio/sonic-tracked black turtles in the Bahía de los Angeles, that many turtles stay in the bay for long periods of time, from a few days to more than a year. These sea turtles were found to have a mean home range of 1662 hectares, and foraged over a distance of about 9 kilometers per day. Acquiring such detailed information is a long and arduous task, but it is the only way we can develop a complete understanding of these mysterious animals and have any hope for ensuring their long-term survival.

In THE END

Sea turtles figure prominently in the cultures of many native peoples. Green sea turtles (*Chelonia mydas*), and to a lesser extent hawksbills, loggerheads, and leatherbacks, were major sources of meat for the Seri, an indigenous people of Central Sonora. Many other people consumed these turtles as well, and in 1990, after most sea turtle population levels had crashed in the Gulf region, the Mexican government imposed an official moratorium on sea turtle hunting. Now the Seri can harvest only limited numbers of the turtles for special ceremonies. Clearly, successful conservation of sea turtles will demand collaboration with native peoples, and the study of these animals requires that we incorporate an understanding of their importance to local cultures. According to Seri mythology, the earth rested on the back of a giant turtle that carried it forth from the depths of the underworld. If sea turtles are to continue to swim the seas, their future now rests upon our backs, and it is up to us to carry them away from the edge of extinction. **S**



Leatherback hatchlings
photo by K. Clifton

ISLAND



San Esteban Island

More than 50 species of lizards inhabit the islands in the Gulf of California, among them turtles, snakes, and several species of the lesser known chuckwalla. Chuckwallas (*Sauromalus* sp.) are medium-sized herbivorous lizards with loose folds of skin along the sides of their bodies. The literal translation of *Sauromalus* is "flat lizard," chosen for these creatures because their wide, flat bodies appear obese.

GIANTS

They're strange,

they're flat,

they're oversized:

they're **chuckwallas!**

Craig Ivanyi

Curator of Herpetology

Arizona-Sonora Desert Museum





Piebald (San Esteban) Chuckwalla
photo by A. Morgan



C. Ivory

Piebald chuckwalla egg.

In the Gulf, the black or spiny chuckwalla (*Sauromalus hispidus*) and piebald or San Esteban chuckwalla (*S. varius*) grow much larger than mainland chuckwallas, possibly due to the reduced number of predators and competitors on the islands, and therefore are considered examples of "island gigantism." There is considerable debate about whether giant chuckwallas descended from the smaller mainland species, or whether those species descended from their larger ilk.

The black chuckwalla is found on about a dozen islands in the Gulf, but the piebald chuckwalla occurs naturally only on Isla San Esteban. The Seri people introduced both of these species to Isla Alcatraz to serve as food, where they freely hybridize with the mainland form (*S. ater*). Because of its limited distribution, the piebald chuckwalla is listed by the United States Fish and Wildlife Service as Endangered and also appears on Appendix I of the Convention on International Trade in Endangered Species (CITES). Potential threats to this species include collection for food and the pet trade, and introduced species that may destroy chuckwalla food plants or consume their eggs.

As the piebald chuckwalla once held a prominent role in Seri culture, concerned Seri worried that their children were losing parts of their natural heritage by not being exposed to this creature. To answer their concerns, Museum staff helped the Seri develop and construct an outdoor enclosure to display

and breed piebald chuckwallas in Punta Chueca, Sonora, Mexico. This enclosure provides a focal point for local people to learn how this species has fit into Seri life over time.

The Desert Museum has a long history of studying and working with the piebald chuckwalla, and has conducted several research trips to Isla San Esteban to investigate the biology and status of this rare species. Over two decades ago, the Museum established a small population and captive-breeding program, which has produced several hundred offspring. The Museum has shared many of these offspring with other zoological parks, aquariums, and universities, both to extend our geographic reach and to facilitate our efforts to protect threatened native wildlife through public education.

Currently, the Desert Museum is developing a studbook for piebald chuckwallas, which combines a catalogue of living and dead animals with a synopsis of current knowledge about the species. This will help to educate individuals working with the species, as well as to facilitate the management of captive chuckwallas. **S**



C. Ivory

The outdoor enclosure at Punta Chueca.



C. Ivory

Black (spiny) chuckwalla (above and below).



M. Kozel

Dear Member:

The 2002 election to fill vacancies on the Arizona-Sonora Desert Museum Board of Trustees is being conducted in conjunction with the publication of this issue of *sonorensis*—the clip-out mail-in ballot is included here. The names of nine candidates appear on the ballot and the candidates have been nominated to serve a term of three years. The following candidates have been selected for nomination by the Nominating Council of the Board of Trustees following a lengthy review of numerous recommended individuals, and have been unanimously nominated by the Board of Trustees.

Priscilla Baldwin - Priscilla pursued her art education studying with various teachers in California, Texas and Colorado. She is currently studying with Katie Lee of the New York Botanic Gardens. Priscilla is the founder of the Garage Class Series in Evergreen, Colorado and also of the Arizona-Sonora Desert Museum Art Institute, and serves on the Board of Directors of the American Society of Botanical Artists. She currently works out of her home studio in the Kerr Gulch, Colorado retreat for which she coordinated design and construction. She is represented by Evergreen Fine Arts and the Garson Gallery in Denver. Born in South Africa and having lived for an extended time in Texas, Hawaii and Colorado, Priscilla has experienced a variety of botanical and natural science environments. Her varied interests include scuba diving, trapshooting, gardening, architectural design and botanical and natural sciences art. Priscilla's work is in many private collections, and in the corporate collections of Amirob & Associates, and BVZ Architects, and in the permanent collections of the Arizona-Sonora Desert Museum and the Hunt Institute for Botanical Documentation.

Laury Browning - Laury is currently the President of the Tucson-based Behan Browning Group which specializes in strategic marketing. Her work experience includes sales, sales training, staff development, promotional marketing, and management as well as the ownership of several broadcast properties. Laury has been very active in a number of community organizations including the Arizona Broadcasting Association, Symphony Cotillion Committee, American Heart Association, Fiesta Bowl Committee, Junior League of Tucson, and the Silver and Turquoise Ball. She serves and has served on various committees at her church and her children's schools. Laury is married and has two children.

Manuel Jorge González Montesinos - Manuel works at the Caborca campus of the University of Sonora where he

teaches sociology in the Department of Social Sciences. He has also served as academic dean, director of the Social Sciences Division of the University and Vice-rector for the 1996-2000 term. In addition Manuel has served as an advisor to local government and Vice-Mayor of Caborca. Manuel received his undergraduate education in Social Science and Humanities at the University of New Mexico in Gallup, and at St. Pius X College in Kentucky. (B.A. Philosophy, 1976). He has done graduate work at the University of Arizona (M. A. Philosophy, 1986). He is now pursuing a Ph.D. in the Educational Psychology Department. He has received the United States Fulbright Grant for International Students and currently has a Mexican Federal Government Grant for Scholars. His public service activities include working as director of the Regional Museum of Caborca, and as a founding member and coordinator of the group organized to restore the Mission of Caborca. He lectures frequently on the history and cultural preservation of Northwest Mexico and has been guest lecturer for the Arizona Humanities Council. He currently presides the Board of Directors of the La Ruta de Sonora Ecotourism Association and serves on the board of Fundacion Mexico in Tucson, Caborca's Municipal Commission for Cultural Preservation and DECIDE, A.C. in Sonora.

Diana Hadley - Diana is a research specialist at the Office of Ethnohistorical Research of the Arizona State Museum at the University of Arizona, where she translates and edits Spanish historical documents. With degrees in archaeology and history from Washington University and the University of Arizona, she specializes in the history of land use and ecological change in the Southwest. She has co-authored book-length land use histories of Aravaipa Canyon, the San Rafael Valley, the Bonita Creek area, the Arizona/New Mexico Borderlands area, and the upper San Pedro Valley. She is co-editor of *The Presidio and Militia on the Northern Frontier of New Spain, 1700-1765* (University of Arizona Press, 1997) and is currently writing a history of the cattle industry in southern Arizona. Raised in Arizona, she is the former operator of a family ranch. She has served on the boards of the Center for Desert Archaeology, the Research Ranch Foundation of the Appleton Whittell Research Ranch, the Arizona Sonora Desert Museum (1987-1990), Native Seeds/SEARCH, and served as a commissioner on the Tucson Pima County Historical Commission. She has organized conferences on grassland restoration, Native American sacred sites, deforestation in the Sierra Madres, restoration of the Santa Cruz River, and is co-founder of the Santa Cruz River Alliance.

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BOARD OF TRUSTEES BALLOT
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This year's ballot may look unconventional, but by including it in *sonorensis* we seek to further the Museum's conservation mission.

BOARD OF TRUSTEES ELECTION

1. Place a check mark next to the names of your choices of candidates (there are 9 candidates for 9 positions).
2. Print your name below exactly as it appears on the address portion of this issue of *sonorensis* and sign the ballot.
3. Cut out this ballot, fold in half as indicated, tape shut and affix a 37¢ postage stamp.

Name: _____

Address: _____

City: _____ State: _____ Zip: _____

SIGNATURE: _____

Priscilla Baldwin

Laury Browning

Manuel Jorge González Montesinos

Diana Hadley

Lisa K. Harris, Ph.D.

Deborah Howard Jacob

Sophia Kaluzniacki, D.V.M.

Winifred M. (Wynee) Warden

Elizabeth T. Woodin

Ballots must be signed and received no later than 5:00 p.m.,
October 28, 2002.

Lisa K. Harris, Ph.D. - Lisa is the founder of the Harris Environmental Group, Inc., a consulting company that focuses on natural resource conservation. Her company has conducted wildlife habitat inventories, designed biological corridors, developed re-vegetation plans for degraded washes, and developed hiking trails with bird-watching opportunities. Lisa holds a B.A. and M.B.A. from the University of Chicago and a Ph.D. from the School of Renewable Natural Resources at the University of Arizona. She is an Adjunct Research Scientist at the School of Renewable Natural Resources, University of Arizona. She has authored or co-authored numerous scientific papers and given many public presentations. She has served as a member of the City of Tucson Landscape Advisory Committee, and the Town of Oro Valley's Native Plant Preservation Ordinance Committee. Lisa was Co-Chair of the 1999 International Symposium on Urban Wildlife Conservation. She is also on the Vestry of St. Phillips in the Hills Episcopal Church. She has had experience in and enjoys fund raising activities, especially "when they don't involve asking for money for herself."

Deborah Howard Jacob - Deborah has most recently worked as the southern Arizona representative of the Department of Commerce and Tourism for the state of Arizona. She held this position from 1990-1998 under Governors Rose Mofford, Fife Symington and Jane Hull. Her previous experience included senior management positions both with private enterprise and with not-for-profit organizations. Among these were positions as executive director of the Arizona Parklands Foundation, creating new parkland and opportunities for environmental and energy education; and director of marketing for the Planetary Design Corporation, an international environmental technologies company. Deborah holds a B.A. in Political Science from the University of Arizona and a Master of International Management from the American Graduate School of International Management. She is on the Board of CEO Software, Inc., a small Tucson-based company, and is an active member of numerous Tucson community boards and organizations.

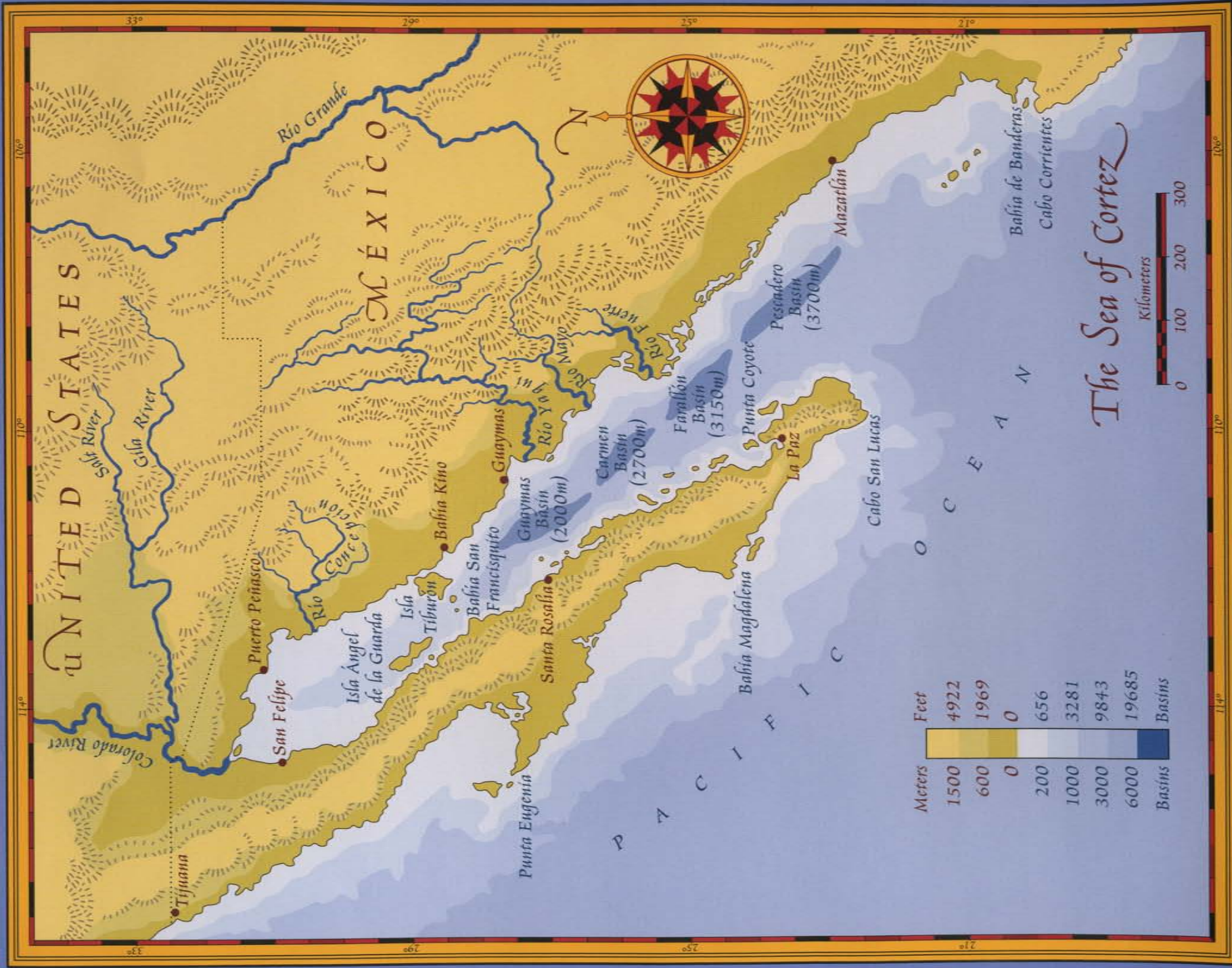
Sophia Kaluzniacki, D.V.M. - Sophia is a practicing veterinarian who owns and operates the Green Valley Animal Hospital, a small animal veterinary clinic. She established this hospital in 1970 and has managed it since that time. Dr. Sophia (she says her last name is too complicated to use) was born in Warsaw, Poland, and with her parents emigrated to the United States. Her family moved to Phoenix. She received a B.S. in pre-veterinary studies from the University of Arizona, and graduated from Washington State

University Veterinary College with a D.V.M. She worked as an Assistant Professor in the Veterinary Science Department at the University of Arizona, involved in both teaching and research. She has served on the Board of the Society for the Prevention of Cruelty to Animals, Inc. since 1970. She also serves on the Pima Animal Control Advisory Committee; she chaired that committee for 12 years. In 1980 she was appointed by Governor Babbitt to the State of Arizona Board of Veterinary Examiners, a position she held for six years. Dr. Sophia is widely known in the Green Valley community.

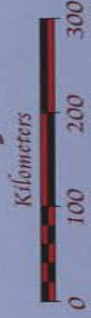
Winifred M. (Wynee) Warden - Winifred has been active in philanthropy and fund raising since attending Rollins College, Winter Park, Florida. Previously, she was affiliated with Children's Hospital at Stanford/Allied Arts Guild for over 20 years, Wilcox Hospital, Lihue, Kauai, Hawaii, and Monterey Hospital, Monterey, California. Wynee is currently President of the Bert W. Martin Foundation, Trustee of Rollins College, Foundation Board of Arnold Palmer Hospital for Children/Women, Originator of Champions for Children Golf Tournament and the Bert Warden Golden South Classic (a track meet serving the southeast and Caribbean Islands), and is active with the Central Florida Zoo. In Tucson, Wynee is involved with Columbia University's Biosphere 2, Big Brothers/Sisters, Black Stallion Reading program, Tohono Chul, and now the Arizona-Sonora Desert Museum!

Elizabeth T. Woodin - Beth's life-long avocation has been natural history. Since 1980, she has been active in Arizona's environmental community beginning with service on the boards of the Arizona Chapter of The Nature Conservancy and the Arizona-Sonora Desert Museum. She later chaired ASDM's executive director search committee. She served five years on the Arizona Game and Fish Commission, chairing it in 1994. At present, she serves on the Mexican Spotted Owl Basin and Range-West Mexican Spotted Owl Working Group, the boards of the Arizona Heritage Alliance and the ASDM, and on the advisory boards of the UA Press and the UA School of Renewable Natural Resources. Her non-volunteer time is spent with her husband, Bill, family and friends, delighting in the desert, its creatures, and their own domestic animal companions. Beth has a B.A. in Art History from the University of Pennsylvania (1968) and a M.A. in Spanish from the University of Arizona (1972). She was the Slide Librarian/Instructor of Art History at the UA for five years, is fluent in both Spanish and French and, for several years, has been assisting the Tucson-Segovia, Spain Sister Cities program.

Cut and fold



The Sea of Cortez



SONORENSIS

Arizona-Sonora Desert Museum

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DESERT MUSEUM



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