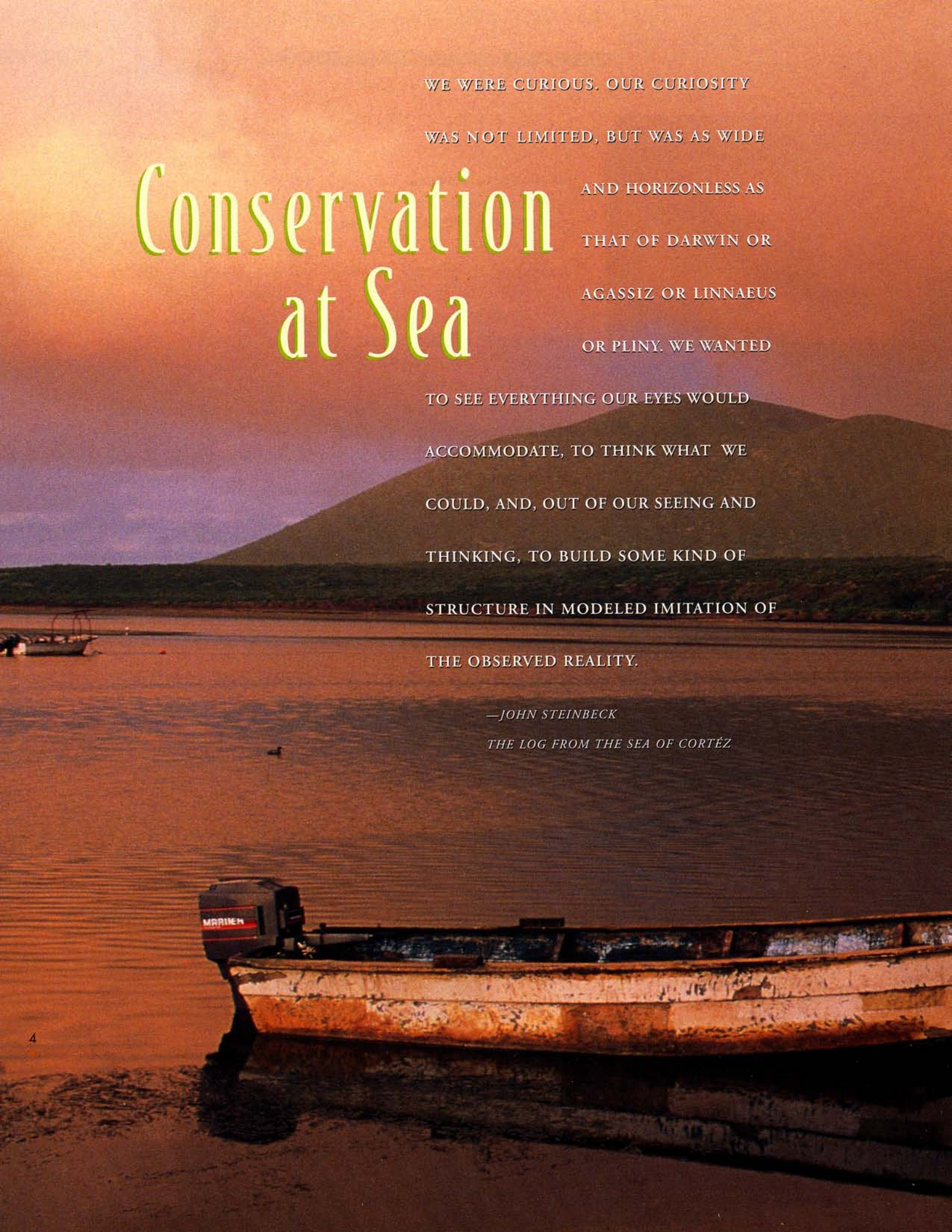
Conservation at Sea

WE WERE CURIOUS. OUR CURIOSITY WAS NOT LIMITED, BUT WAS AS WIDE AND HORIZONLESS AS THAT OF DARWIN OR AGASSIZ OR LINNAEUS OR PLINY. WE WANTED TO SEE EVERYTHING OUR EYES WOULD ACCOMMODATE, TO THINK WHAT WE COULD, AND, OUT OF OUR SEEING AND THINKING, TO BUILD SOME KIND OF STRUCTURE IN MODELED IMITATION OF THE OBSERVED REALITY.

—JOHN STEINBECK

THE LOG FROM THE SEA OF CORTÉZ



Binational Coalition Builds a Model for Success

BY MARIO C. AGUILERA

Enric Sala's proximity to the sea as a child was one of many influences on his interest in marine ecology and conservation biology. Born and raised in Girona, 32 kilometers (20 miles) from the coast of Catalonia, Spain, Sala spent many memorable summers with his family along the Mediterranean, even learning to snorkel before he could swim.

But it was as an undergraduate at the University of Barcelona that Sala's love for the ocean transitioned into a career. Witnessing first-hand the dramatic effects of fishing on marine ecosystems left an indelible impression.

"When I started diving off the Medes Islands Marine Reserve on the Catalonian coast in the Mediterranean, I saw so many striking differences between the reserve and the fished areas nearby," Sala explained. "The differences were so dramatic. I discovered the effects of fishing on whole communities. I decided right then to study that particular marine reserve—and that's what led me to the research I'm doing now."

Since joining the Scripps faculty in July 2000, Sala's research has focused on the impacts of human activities on coastal environments, including the direct and indirect effects of fishing. He investigates interactions among species in food webs as well as ecological conditions critical for coastal fishes to successfully reproduce and maintain viable populations. Sala has recently been appointed as deputy director of the new Center for Marine Biodiversity and Conservation at Scripps.

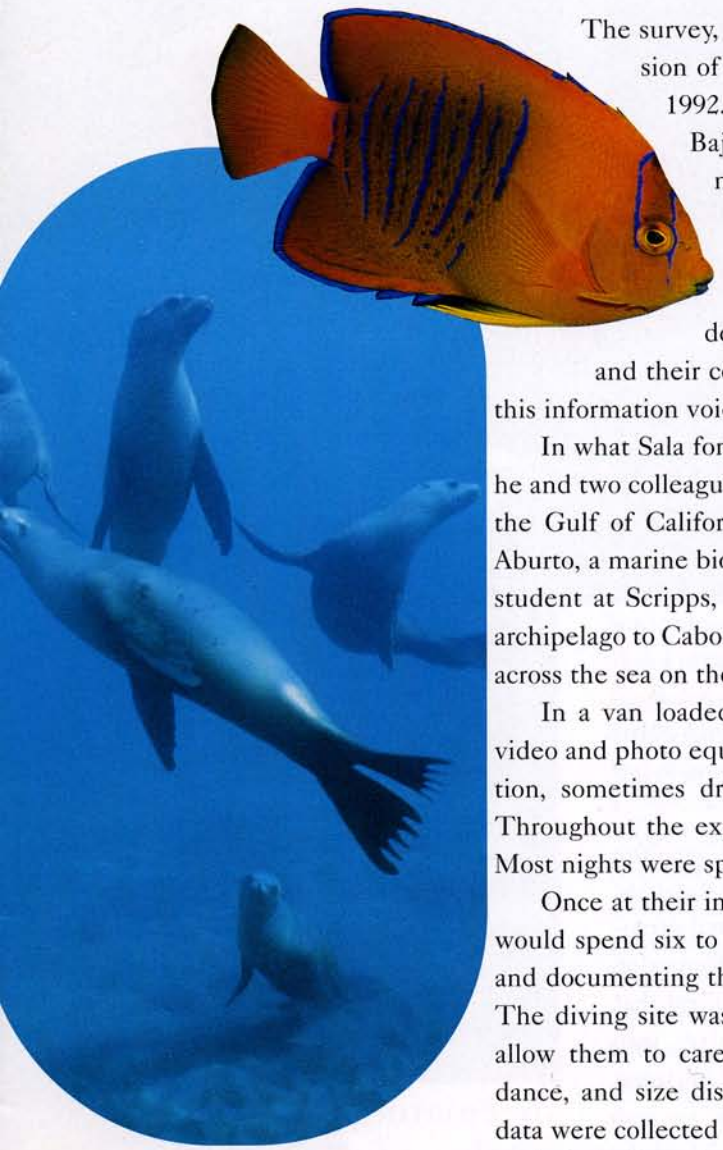
Although he continues to study the coastal ecology of the Mediterranean, as well as the coral reefs off the coast of Belize in Central America, it is his research in the Mexican Gulf of California, also known as the Sea of Cortés, that has drawn the attention and acclaim of other scientists and government officials.

The majestic beauty of the Gulf of California has never been more vividly portrayed than by novelist John Steinbeck. In *The Log from the Sea of Cortéz*, Steinbeck recounts his exploration of the sea with biologist Ed Ricketts, noting in 1940 that fishing boats were "bringing up tons of shrimp, rapidly destroying the species so that it may never come back and with the species destroying the ecological balance of the whole region." Today, journalists detail a worse situation. In an April 2002 article, the *New York Times* noted that the 875 species of fishes and 30 species of marine animals in the Gulf of California have been killed indiscriminately for years, and that greed and corruption were draining this "exhausted," but not yet "dead," sea. The article quotes Víctor Lichtinger, Mexico's environmental minister, as saying that if nothing changes, "in a few years, you could end up without any fish in the sea."

Against this backdrop, Sala and his colleagues have turned a comprehensive scientific survey into a working model for the conservation of the Gulf of California that might be a forerunner for similar efforts around the world.

Above, *Enric Sala analyzes organisms collected from the Gulf of California.* **Below,** *Fishing boat near Tortuga Island in the gulf.*

> We wished to cover as much ground as possible, to establish as many collecting stations as we could, for we wanted a picture as nearly whole of the Gulf as possible. Nights at anchor in the Gulf are quiet and strange. The water is smooth, almost solid, and the dew is so heavy that the decks are soaked. The little waves rasp on the shell beaches with a hissing sound, and all about in the darkness the fishes jump and splash.
>
> —*The Log from the Sea of Cortéz*



In the Gulf of California the diversity of fishes, invertebrates, and marine mammals makes this region one of the richest ecosystems in the world.

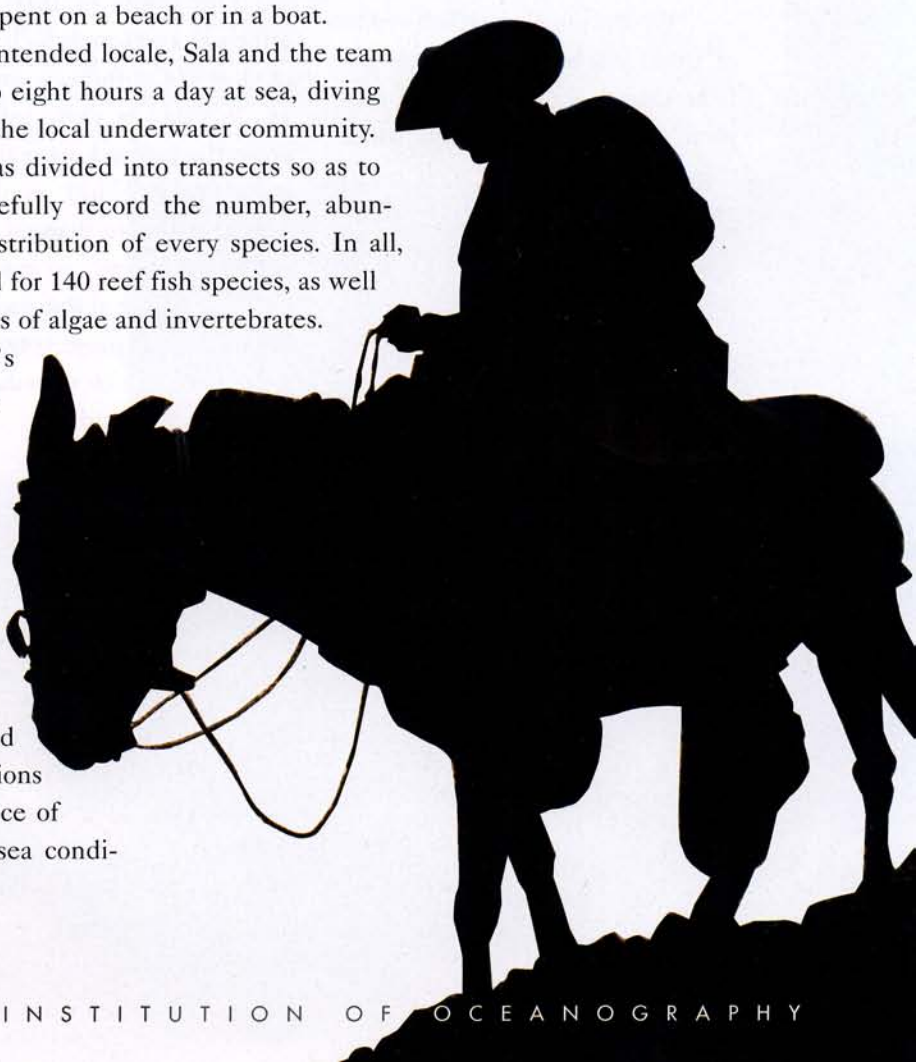
The survey, the Reef Fauna Conservation Project, is a major extension of a program started by the Birch Aquarium at Scripps in 1992. In collaboration with the Autonomous University of Baja California Sur (UABCS) in La Paz, Sala and Scripps marine ecologist Paul Dayton intended to study every reef system in the Gulf of California. While information was available on how many species of various groups of organisms, including reef fishes, lived in the sea, detailed, quantitative information about these animals and their communities was sparse. These researchers hoped to fill this information void.

In what Sala fondly looks back on as a "beautiful" research experience, he and two colleagues spent three months in 1999 traveling to 60 sites along the Gulf of California to survey fish populations. Working with Octavio Aburto, a marine biologist at UABCS, and Gustavo Paredes, now a graduate student at Scripps, the team surveyed the gulf from the Las Encantadas archipelago to Cabo San Lucas on the Baja California side and a shorter span across the sea on the west coast of the Mexican state of Sonora.

In a van loaded with an inflatable boat, diving gear, computers, and video and photo equipment, the scientists often traveled hours to a destination, sometimes driving through the desert to reach desolate locations. Throughout the expedition, they slept in hotels on only a few occasions. Most nights were spent on a beach or in a boat.

Once at their intended locale, Sala and the team would spend six to eight hours a day at sea, diving and documenting the local underwater community. The diving site was divided into transects so as to allow them to carefully record the number, abundance, and size distribution of every species. In all, data were collected for 140 reef fish species, as well as dozens of species of algae and invertebrates.

With a day's diving complete, the team recorded their data in laptop computers and chronicled their work in field notebooks. They described the underwater species encountered and other observations such as the presence of a red tide or the sea conditions that day.

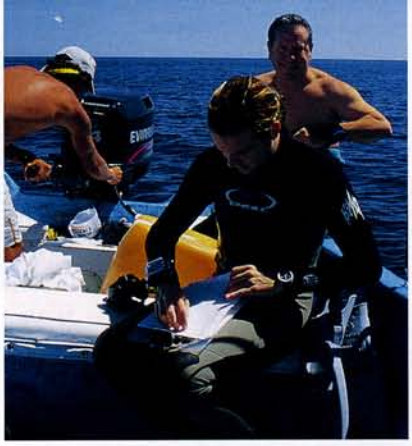


We suppose this was the mental provisioning of our expedition. We said, "Let's go wide open. Let's see what we see, record what we find, and not fool ourselves with conventional scientific strictures."

—The Log from the Sea of Cortéz

The next day Sala and his team would load their equipment and head off to a new destination, repeating the routine. Although they knew the general diving locations they wanted to target, they acquired their most useful information from local fishermen.

"We developed a relationship of trust and confidence with the fishermen," Sala said. "We told them about our science and, when they trusted us, they took us to special places where they caught more fish. We knew things about the species they were targeting and they helped us with specific information. In the end, most fishermen agreed there are important life processes of fishes that needed to be protected."



At the conclusion of the three-month expedition, Sala and his colleagues decided to return to the Gulf of California at various intervals to continue documenting spawning aggregations and nurseries for reef fishes, ecological interactions between habitats, dispersal of fish larvae, and other ecological processes.

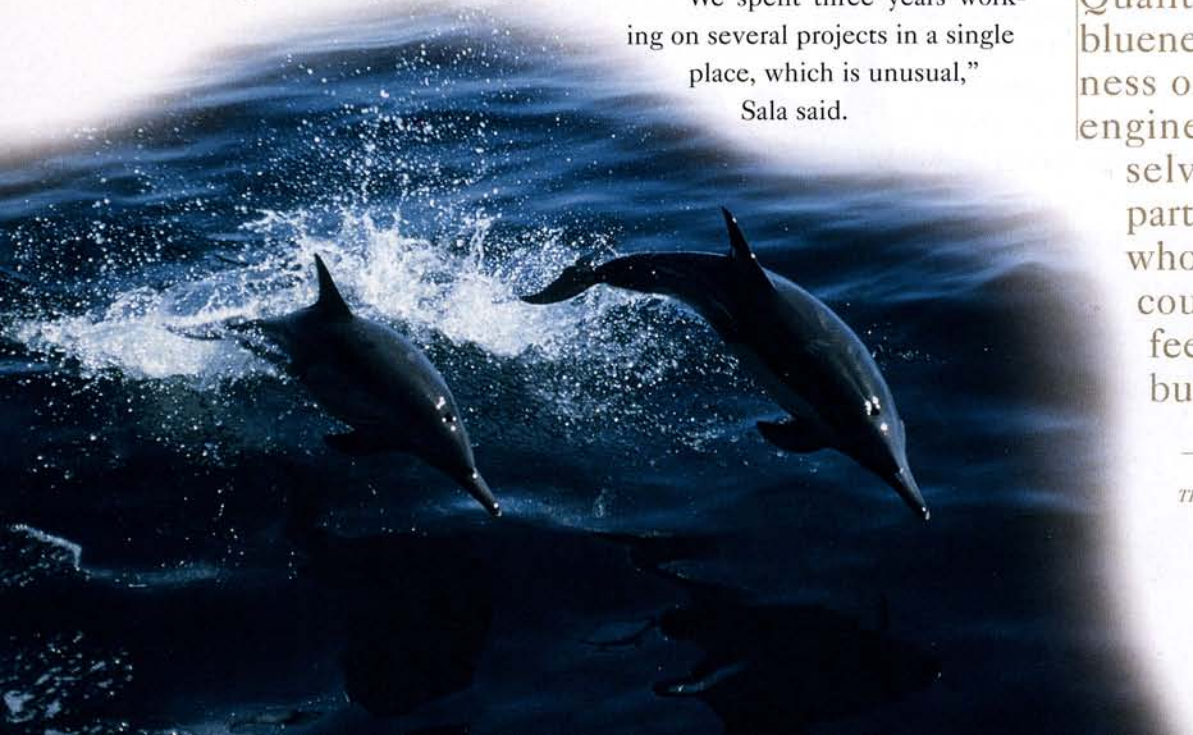
The result of their ongoing efforts is a uniquely rich database of Gulf of California coastal ecology. In fact, as their information grew, the researchers realized that their work could evolve into something more than an in-depth ecological survey.

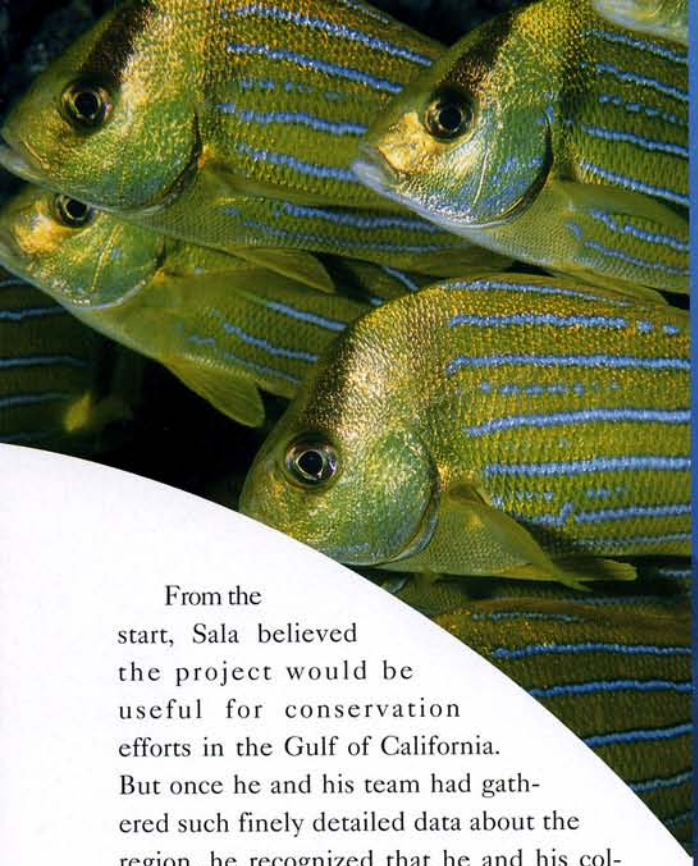
"We spent three years working on several projects in a single place, which is unusual," Sala said.

"Typically research projects cover only one aspect, such as the reproduction of fishes or the dispersal of larvae. We tried to study everything. We made this an extremely intensive effort."

This little trip of ours was becoming a thing and a dual thing, with collecting and eating and sleeping merging with the thinking-speculating activity. Quality of sunlight, blueness and smoothness of water, boat engines, and ourselves were all parts of a larger whole and we could begin to feel its nature but not its size.

—The Log from the Sea of Cortéz





From the start, Sala believed the project would be useful for conservation efforts in the Gulf of California. But once he and his team had gathered such finely detailed data about the region, he recognized that he and his colleagues had enough information to make recommendations for establishing a network of marine reserves, areas off limits to fishing that could help protect marine life.

To help determine reserve locations, they, along with Ivan Parra, a scientist at the Gulf of California Program of World Wildlife Fund, modified a computer-based mathematical model. The innovative model produces a geographical configuration of planning units, spanning roughly every 50 kilometers (31 miles) of the gulf, and estimates the minimum number of reserve areas necessary to meet conservation goals while taking into account the socioeconomic realities of the area such as fishing pressure.

"In designing marine reserves, people have typically used only one variable, usually the number of species or the presence of spawning grounds. We used all of our data on species abundance and distribution, habitats, spawning, nurseries, and dispersal of larvae," Sala said. "On the one hand, we want to make sure that the species that are threatened by fishing avoid local extinction, which is more common than most people think. On the other hand, we want to protect a representative sample of the marine biodiversity in the Gulf of California."

This project is also part of a larger effort led by Mexican institutions to conserve marine biodiversity in the Gulf of California. The Gulf of California programs of World Wildlife Fund and Conservation International, Fondo Mexicano para la Conservacion de la Naturaleza, The Nature Conservancy, and local nongovernmental organizations formed the Coalition for the Sustainability of the Gulf of California, and have been working with more than 180 scientists from 32 institutions in Mexico and the United States to identify conservation priorities for the gulf. The coalition will present a conservation plan to the Mexican environmental agency this summer that is based on the data produced in Sala's project as well as data provided by Mexican experts in other fields.

Recognized as a "model model" of science and conservation, the Gulf of California results are attracting attention both within and outside the scientific community.

"What is most exciting about Enric's work is that he has been able to learn about all the different habitats to arrive at a unique inventory and understanding of the Gulf of California," said Scripps Institution Director Charles Kennel. "The amazing part of this technique is the computerized output for dozens of different solutions. You can take this technique to politicians and other decision makers as a tool to help them work within their economic constraints. It's a science-based instrument to help society make decisions—this is the role that science should be playing."

Opposite page, left, *Beached turtle carcass near La Paz, Baja California.* **Middle,** *Enric Sala and Scripps Dive Master Wayne Pawelek prepare for a day's dive near Loreto, Baja California.* **Right,** *Scripps graduate student Gustavo Paredes taking fish census near Loreto.*

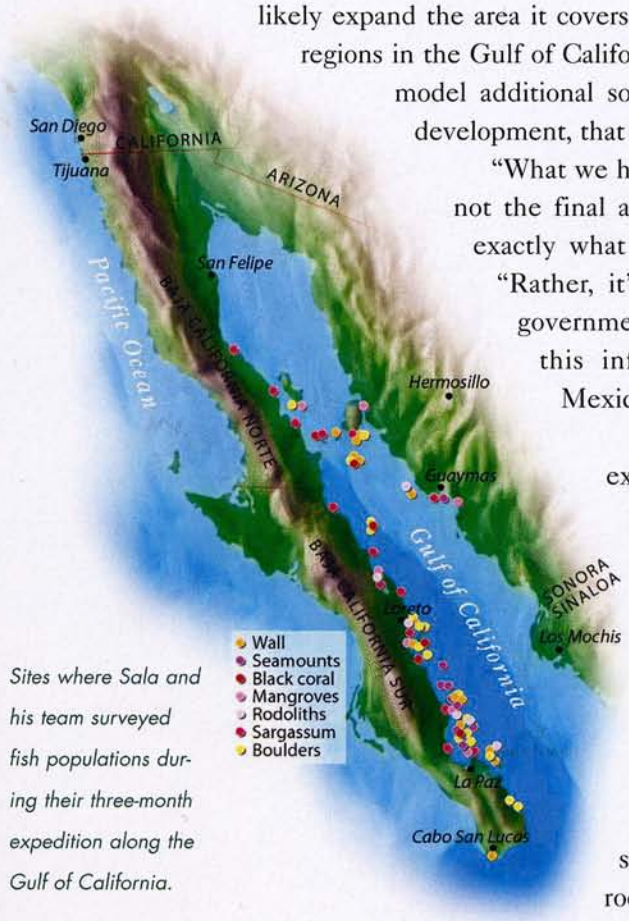
A smoothly working larger animal surviving within itself—larval shrimp to little fish to larger fish to giant fish—one operating mechanism. And perhaps this unit of survival may key into the larger animal which is the life of all the sea, and this into the larger of the world.

—*The Log from the Sea of Cortéz*

Despite the model's success, Sala recognizes its limitations. He will likely expand the area it covers beyond the rocky coast and reef regions in the Gulf of California and will incorporate into the model additional social components, such as coastal development, that affect the ecosystem.

"What we have proposed and obtained here is not the final answer—it's not a characterization of exactly what will happen in the region," Sala said. "Rather, it's a base. It's a tool. The leading nongovernmental conservation organizations are using this information to work together with the Mexican government."

Thus, Sala is prepared for anything—except to sit idle on the merits of four years of work. He is returning to the Gulf of California to look deeper into issues of "connectivity" in the region. How connected are the various habitats that his team so exhaustively documented? Certain species such as snapper will produce offspring in offshore islands, but their larvae will only settle in mangroves. After a period, juvenile snappers leave the mangroves for the rocky shores. Aburto and Sala are now investigating the processes involved in such movements and exchanges between habitats.



Sites where Sala and his team surveyed fish populations during their three-month expedition along the Gulf of California.

"We need to conserve all these ecosystems for many reasons, including knowing how systems function with all their components in place, without human disturbance," Sala said. "This is the only way that we will be able to predict future changes due to our activities, and to mitigate them."

Top, *Mangroves act as a nursery for many fishes in the gulf.* **Bottom,** *Enric Sala and John Steinitz of Scripps collect and measure juvenile fishes with students from the Autonomous University of Baja California Sur.*

SUPPORT SUSTAINABLE SEAFOOD

The surge in America's appetite for seafood during the past 50 years has contributed to the exploitation of fish populations throughout the world's oceans. You can help protect these fishes by eating seafood—from menus and markets—whose populations are currently considered healthy. Listed below are fishes that need to be protected (red) and those that are good choices for consumption (green).

NEED TO BE PROTECTED

- Atlantic Cod
- Lingcod
- American Lobster
- Monkfish
- Orange Roughy
- Rockfish/Pacific Red Snapper/ Rock Cod
- Sablefish/Butterfish/Black Cod (Alaska and wild caught)
- Salmon (farmed)
- Atlantic Sea Scallops
- Chilean Sea Bass/Patagonian Toothfish
- Shark (all)
- Spot Prawns (trawl caught)
- Prawns (wild caught or farmed)
- Swordfish
- Bluefin Tuna

GOOD CHOICES FOR CONSUMPTION

- Calamari/Squid
- Catfish (farmed)
- New Zealand Cod/Hoki
- Halibut (Alaska)
- Dungeness Crab
- Mahi-Mahi/Dolphin Fish/Dorado
- Salmon (Alaska and wild caught)
- Striped Bass (farmed)
- Sturgeon (farmed)
- Tilapia (farmed)
- Rainbow Trout (farmed)

Source: Monterey Bay Aquarium

ENRIC SALA ON MARINE RESERVES

ENRIC SALA BRINGS equal parts scientific expertise and passion for conservation to his role as deputy director of the new Center for Marine Biodiversity and Conservation (CMBC) at Scripps Institution of Oceanography.

The center is part of Scripps Institution's effort to understand the dynamics of marine ecosystems and develop strategies to prevent and reverse biodiversity collapse, to train new scientists in biodiversity and conservation across various disciplines, and to communicate science to policy makers and the public.

We recently spoke with Sala about these issues.

Mario Aguilera for *Explorations*: Why should people care about conservation, especially in the oceans?

Enric Sala: Some people ask, why do we need so many species in the tropical forests or in coral reefs? The answer is that we need to be careful, and determine the role of different species in an ecosystem, and how the ecosystem is built. Certain species can produce rapid changes in an ecosystem, while others might not.

So why do we need to conserve all biodiversity? First, a complex system is much more difficult to destroy than a simple system. Ecosystems with a high diversity of species are "healthier" and less open to problems such as disease or invasions. In fact, we are still pretty ignorant about what happens when inconspicuous species disappear. We probably need complex ecosystems for the sake of our species.

Second, natural chemical products found in living organisms can potentially be very important for society, but there are probably millions of species that haven't even been described. Some may have potential for pharmaceutical drugs and other uses.

The third reason is personal. As we continue to fish the larger species in the ocean, ecosystems are being reduced to populations of smaller and smaller species. Personally, I don't want to live in a world dominated by jellyfish and microbes.

MA: How are humans altering the natural state of the oceans?

ES: We are exploiting the oceans in many ways, mainly by fishing. Not only are we depleting the populations of many species, but we are also reducing the complexity of marine ecosystems for the benefit of the complexity of human societies.

Today, it is virtually impossible to swim in a marine ecosystem that has not been altered by humans. We are heading toward coastal ecosystems dominated by toxic algae and bacteria, instead of our former ecosystems where the most conspicuous living beings were large fishes, marine mammals, and turtles. To build up a coral reef takes centuries, but they are very easy to destroy.

MA: You are working in support of marine reserves, areas in which fishing is banned and marine life and ecosystems are allowed to flourish. But these areas have been criticized by those who doubt that marine reserves quickly solve and reverse fish depletion problems. How do you respond to such critics?

ES: On land, when you create a national park, you preserve an ecosystem and all the species that live in the ecosystem. Nobody created Yellowstone National Park for the purpose of having more bison or more wolves or more bears so that you can keep hunting them outside the park. But with the sea, we're told everything we do with regard to management or marine reserves has to enhance fisheries in the short term.

Marine reserves help, but it's dangerous to say that if you create marine reserves, the fishery outside of the reserve will do much, much better. To detect an increase in fish abundance, statistically, the increase outside the reserve must be higher than the natural variability, which is already a lot.

Fish populations will vary from year to year because of many factors, including natural cycles. So it's dangerous to promise that the existing marine reserves will help the prowess of fisheries. They are only an additional management tool, especially because most existing marine reserves are so small you cannot even see them on a regional map.

The problem is not marine reserves, the problem is overly high expectations for what

we have now. Biodiversity is not a luxury as some want to put it, and its preservation is essential for the survival of our species.

MA: How do fisheries affect the supply and demand for fish?

ES: The demand for seafood is just amazing—and increasing. We've already seen the collapse of Atlantic cod and other fishes. Now we're catching species with long life spans such as orange roughy, rockfishes, and large groupers, many of which are now seriously threatened.

There is no way we can have large-scale sustainable fisheries for most large species with the present demand. A massive hunting operation cannot be sustainable. But fisheries management—the way to ensure that the hunting operation can go on as long as possible—is an experiment. In science, if an experiment doesn't work, we try something else. Let's try very large marine reserves too. It would be another experiment, but let's try them and give them enough time.

However, it's important to realize that there is a double standard here: You can experiment with exploitation, but many people believe you should not experiment with conservation. In the end, the goals are the same, what is different is the vision: myopic short term versus wise long term.

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