A coral reef is a living organism, and a living reef gives our islands life. It is both protector and provider—a reservoir of food as well as a buffer against the destructive power of the sea. Hawaii’s coral reefs and nearshore waters are home to more than 7,000 marine life forms—a quarter of them found nowhere else in the world. This spectacular diversity can still be seen in the protected waters of the Northwestern Hawaiian Islands, but in the main Hawaiian islands, pollution, sedimentation, alien species, overfishing, and other threats are degrading our reefs. Scientists estimate that our nearshore fisheries have declined by 75% over the last century. Fishermen tell us there are “way less fish.”

Today, many scientists, fishermen, local communities, and government agencies are working to restore our resource—through enhanced management, stepped-up enforcement, and a new spirit of cooperation that serves the greater good.

Restoring the health of our coral reefs is essential if we are to create a sustainable future for our islands.

Hawaii’s cultural traditions and our island way of life are intimately tied to the sea. When we allow our reefs to degrade, we lose the important ecological and economic services they provide, as well as a big part of the collective natural and cultural heritage of our islands. The quality of our environment and the quality of our lives are determined, in part, by the quality of life that we pass on to our children.

It is time we take care of our oceans and our oceans will take care of us. In Hawaii, living reefs are an everyday, baseline norm. We all have a stake in their future, for in many ways, they determine ours.
Corals are one of the oldest lifeforms on earth and coral reefs have existed for many millions of years. They are home to such a rich diversity of life that they rival rainforests as biological storehouses. Coral reef communities fringe the entire Hawaiian archipelago, adjusting to the constant pressure of the sea. More than 5,000 species of fish and millions of marine invertebrates shelter in their brilliance. In fact, more than one in eight species on earth can be found in coral reefs. Our island lifestyle depends upon our coral reefs.

Existing just below the surface of the ocean, out of ordinary sight, coral reefs provide us with countless benefits—from the fresh fish we eat to the surf we ride and the beaches we enjoy. Coral reefs occupy less than 1 percent of the ocean’s surface, yet they are home to one quarter of the world’s fish species. Filled with crevices, holes, niches, and ledges, coral reefs provide safe breeding areas, and hiding habitats for fish. They are nurseries for the newborn, secure hideaways for juveniles and adults, and abundant sources of food for fish, shellfish, and invertebrates. Around the world, hundreds of millions of people rely on coral reefs for food, income, and tourism. In Hawaii, over 150 species of fish are among the many delicacies our reefs provide to Hawaii’s people.

“GIFTS from the Reef
In more ways than we might realize, our island lifestyle depends upon our coral reefs.”
Nature's Breakwaters

For the people of Hawaii and millions of others who live on tropical islands, coral reefs are nature’s breakwaters. They buffer the land and coastal inhabitants from the ocean, cushion the shoreline, provide nesting habitat, anchor coastlines against storms and high waves, and protect seashores from sand erosion. Without the protection of the reef, our beaches would be severely eroded and our coastlines would be in jeopardy.

Underwater Parks

As islanders, we swim in the cool at Kualoa Point and Makaha Cove, swim in protected waters, scuba dive and fish reefs throughout the islands, and ride waves at dozens of reef-generated surf breaks. More than 7 million visitors come to Hawaii every year, and almost all of them engage in these same ocean-related activities. It is estimated that Hawaii's offshore reefs contribute more than $350 million a year to the state's economy, or about $1 million a day.

Sand Makers

We can thank our living reefs for Hawaii's white, sandy beaches. Beach sand is created from coral fragments ground down by wave action. Coral is also ground up into sand by parrotfish, which feed on soft, thin coral tissue and excrete pulverized limestone in their waste. The native marine algae Halimeda is yet another source. It deposits calcium carbonate/limestone in its leaves, which break down and become sand.

Subsistence and Recreation

Fishing is a way of life in Hawaii—part of our cultural heritage and our local culture. The reef provides food for subsistence fishing families in Hawaii, and is an important recreational activity for many others. Sharing our catch with family and friends is an island tradition as old as fishing itself.

No Reef, No Surf

In Hawaii, the quality of the surfer's wave is dependent on the shape of the reef. Because there is no continental shelf (a gradual decline from the shoreline to the deeper ocean) around the Hawaiian islands, ocean swells approach the shore unhampered. Most of the waves that surfers ride are formed when the swells hit the reef—rising, breaking, and curling.
Coral reefs are the planet’s largest living structures, reaching the dimensions of Australia’s 92,000 square-mile Great Barrier Reef. The raw material of this construction is the calcium that polyps take in from the sea and convert to an external limestone skeleton. One generation of coral colonies builds atop the last, creating the foundation of a vast underwater architecture. Vast branching orchards give way to sleek plateaus. Rivulets of tiny grains wind their way into serpentine canals. Impressive monuments are capped off by everything from jagged turrets to rows of domes in the shape of cauliflower heads. The entire reef pulsates with the comings and goings of thousands of marine creatures. They drift past in great schools, dart backwards and out of microscopic passageways, and hide in cracks and crevices and holes. Forget the idea of the ocean as a watery void – in reality, it is a finely integrated cosmos and the coral reef, more than anything, is what keeps it alive and vibrant.

Rising out of the monotony of the open ocean, the coral reef appears like a submerged metropolis, its structure a riot of form and color. Not bracingly exact blue yet dark porcelain. Branches of tiny grains wind into serpentine canals. Intricate monuments are capped off by everything from jagged turrets to rows of domes in the shape of cauliflower heads. The entire reef pulsates with the comings and goings of thousands of marine creatures. They drift past in great schools, dart backwards and out of microscopic passageways, and hide in cracks and crevices and holes. Forget the idea of the ocean as a watery void – in reality, it is a finely integrated cosmos and the coral reef, more than anything, is what keeps it alive and vibrant.

The Architecture of the Reef

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At the core of the coral reef is a remarkable exchange of “goods and services” between two different life forms—a single-celled alga and a plant. The coral polyp, one of the simplest of all animals, is little more than a tube, capped with a mouth and fringed with stinging tentacles. The polyp has many reproductive strategies, but it mostly makes new life by cloning itself. This produces colonies of genetically identical polyps attached to one another. The polyps nourish themselves with their very own internal gardens of single-celled algae known as zooxanthellae. The algae keep the polyps healthy by converting the light energy into carbohydrates, oxygen, and food, which the polyps then release to the water column. The algal zooxanthellae living in the polyps provide food and oxygen, and the polyps provide the algal zooxanthellae with protection from predators and other dangers.

M a s t e r B u i l d e r s

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Finally, marking the spot where magma first erupted from the Earth’s molten core and heralded the existence of the mid-Pacific chains some 50 million years ago, there are the seamounts and atolls of the Northwestern Hawaiian Islands. Their embrace of blue lagoons extends 1,200 miles to Kure Atoll. Beyond Kure, the land is subsiding so fast it outpaces coral growth, and the reef is literally drowning. This end point, which paradoxically was once the beginning of the volcanic chain, is known as the Darwin Point.

Over evolutionary time, Hawaii’s isolated Pacific location gave rise to one of the world’s unique coral reef communities. The first corals and marine creatures floated here on ocean currents and black-lanced down to begin life anew, 2,500 miles from the nearest continental land mass. Strong currents and cooler temperatures at the northern edge of the tropics presented challenges for the new species, which depend on warm, shallow water. Out of hundreds of species of coral, just five dominate in Hawaii. Within these hardy groups, remarkable species evolved that were adapted to the new habitat.

This moray eel isn’t eating his dinner—he’s getting his teeth cleaned by a scarlet cleaner shrimp.
Today, about 25 percent of Hawaiian corals are found nowhere else in the world. The same is true of roughly a quarter of the 7,000 marine creatures supported by Hawaii’s coral reefs.

This tailored attunement of species to a specific place is called endemism. No other coral reefs of similar size and expanse on the planet have a higher rate of endemism than Hawaii.

The downside of Hawaii’s endemism is that there is no replacement pool should our corals and marine life perish. This vulnerability underscores one of nature’s hard-earned lessons: that the rarest of creatures are sometimes the most valuable.
Ancient Ties to the Reef

Akapa (coral reefs) and the infinite ocean world were of enormous importance to ancient Hawaiians.

The major source of protein in the Hawaiian diet was seafood, so careful management of ocean resources was essential. The Hawaiians affectionately referred to inshore areas as the "meat bowl" and fished or foraged in the shallows or on the reef daily (Hawaiians today often refer to the reef as the "icebox").

Women did the bulk of the gathering, accompanied by children who soon learned the skills to tease lobster and octopus from their holes, pry shellfish from the rocks, identify the tastiest limu (seaweed), and trap fish with basket and net. Yet even with a pre-contact population estimated as high as 1 million people—comparable in size to our population today—the Hawaiians harvested from the sea in a manner that sustained healthy and resilient fish populations and reef life. Their approach to caring for resources was both spiritual and highly practical, and based on a simple conservation ethic: "If you care for the ocean, the ocean will care for you."" (Ahupua‘a)

The development of loko i‘a (fishponds) allowed Hawaiians to extend and control the bounty of the reefs. Hawaiians developed a sophisticated system of aquaculture by walling in areas of inshore water, usually around reasources where fresh water entered the sea. Gates allowed water to circulate and pass fish to enter while keeping undesirable fish, such as larger predators, out. As the fish matured and became large enough to escape from the pond, they were harvested for food. The fish that were not big enough to harvest were released back into the sea, where they would spawns and replenish the fish supply. The fishpond was thus part of the larger ahupua‘a system in which resources were sustainably managed from the mountains to the sea.

Loko i‘a

Under the traditional system, the ali‘i (chiefs) held all land in trust as gifts from the gods, and apportioned use rights within each ahupua‘a to their representatives, or konohiki, who were responsible for proper protocol in how resources were to be managed. The konohiki enforced seasonal regulations linked to religious observances, but they would also put in place or remove restrictions based on close observation of local conditions. The konohiki were guided by centuries of passed-down knowledge, often in proverbs such as "when the pandanus fruit ripens, the sea urchin is fat with eggs." The wisdom and authority of the konohiki was considered absolute.

Konohiki

Knowledge of the ocean fisheries and reefs, and their resources was embodied in the layai‘ana‘u, a select group of fishing experts whose ranks included both chiefs and commoners. For these men, fishing was a science that carried with it a vast legacy of knowledge. The layai‘ana‘u knew all the different types of fish, their habitats and food preferences, spawning seasons and migration patterns, as well as the various techniques for catching them. Together the konohiki and layai‘ana‘u, as well as a wide range of other practitioners in environmental matters, worked to implement the long-term management and use of their resources.

Lawai‘ana‘u

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Wise Management

The ways in which limu (seaweed) were used illustrates just how thoroughly Hawaiians knew and utilized the resources of the reef. Hawaiians have over 60 names for edible types of limu, including limukala which was needed to begin the Ho’oponono ceremony (to make things right or just) in times when conflicts or problems were addressed in a family or community. Seaweed was also used as medicine, for ritual purification, and as a love potion by hula dancers. But seaweed, sometimes affectionately called kalo, is a laurel of the long-lived fish of the way station in the reef, an essential part of the diet, along with fish and poi. It was a particularly important source of protein and calories for women, for whom several foods, including certain types of fish, were kapu.

An Intimate Knowledge of Place

The Hawaiian ahupua’a system of land management allowed for local control over resources. Each island was divided into ahupua’a, typically wedges of land running from an apex at a high point on the island to the coast and out to the far edge of the reef. Each ahupua’a sustained a community of extended families—‘ohana—linked by intermarriage and the span of generations living in that place. That each ‘ohana intimately knew the land and adjacent marine world that sustained them.

Kinship with the Ocean

Hawaiians revered the ocean and its myriad life forms with a sense of being bound in a reciprocal relationship, through ‘aumakua (ancestral family guardians), which took marine forms such as shark or stingray, sea urchin or sea turtle. This spiritual kinship was constantly affirmed through taking care of fishingshrines, making ritual offerings, and gathering from the ocean only what was needed.

Kapu!

The kapu system was an important way that Hawaiians conserved resources. Placing a resource under kapu (proclaiming the taking of it is taboo at certain times of the year) acknowledged that the things that sustained families were gifts from the gods. Kapu were placed or lifted according to an understanding of natural cycles (personal and lunar cycles, and the corresponding reproductive cycles of marine life), and close observation of local conditions. Reefs were much affected by changing wave conditions from summer to winter, and the effects of the monsoon on carriers and tides. By observing the peak spawning cycles of fish or when seaweeds produced eggs or生素nated seaweed, Hawaiians would avoid harvesting at times that disturbed these natural cycles.

Troubled Waters

Leilimu kala

If the threats are not removed, a reef becomes susceptible to invasion, disease, fragmentation, and even death. Biologists tell us this is already happening in the main Hawaiian Islands, and that people are causing most of the damage. Overfishing, pollution, habitat destruction and the introduction of alien species are all human activities that jeopardize the long-term health of our reefs. Hawaii is not alone. Coral reefs in at least eighty countries are threatened, and within the next fifty years the majority may be damaged beyond repair. The good news is that we still have time to reverse. If we act in time, we can still heal our troubled waters and bring our reefs back from the brink.

Coral is a living animal, and a coral reef resonates with life. But like any living system, it suffers from prolonged exposure to disturbance and stress. If the threats are not removed, a reef becomes susceptible to invasion, disease, fragmentation, and even death. Biologists tell us this is already happening in the main Hawaiian Islands, and that people are causing most of the damage. Overfishing, pollution, habitat destruction and the introduction of alien species are all human activities that jeopardize the long-term health of our reefs. Hawaii is not alone. Coral reefs in at least eighty countries are threatened, and within the next fifty years the majority may be damaged beyond repair. The good news is that we still have time to reverse. If we act in time, we can still heal our troubled waters and bring our reefs back from the brink.
Hawaii’s coral reefs provide us with fish for both food and the aquarium trade. But increasing numbers of people are fishing, and they’re using more sophisticated gear, vessels, and technology to increase their catch. As a result, we are harvesting marine life faster than it can be replenished through natural growth and reproduction. Studies show that fish stocks are 20 to 25 percent of what they were a century ago, and that the aquarium trade in west Hawai’i has increased six-fold in the past twenty years.

Declining Catch

Collision and Recreational Overuse
Simply stepping on a reef can damage or kill coral. Coral trampling by uninformed snorkelers, divers, surfers, and other marine recreational users can cause severe localized damage to reefs. So can improper boat anchoring and mooring. With so many people utilizing our coral reefs, the damage adds up. Eight million people annually flock to Waikīkī Beach, and the declining health of that reef reflects the severe overuse. Even Molokini islet off Maui, which is accessible only by boat, receives half a million visitors each year.

Coastal Development
Improper coastal development is one of the greatest threats to our reefs, creating runoff of sediment and pollutants that cover and suffocate coral. In Hawaii, where the terrain slopes dramatically seaward, no place is more than 20 miles from the coast. Most development is within three miles. Many kinds of runoff damage coral reefs, seaweed discharge (from fields), fertilizers (nutrients encourage the growth of algae that cover the reefs), herbicides and pesticides from homes and golf courses, and oil, gas, and toxic chemicals from city streets and storm drains. The effects are especially pronounced in harbors and bays, such as Kane'ohe Bay on O'ahu, where stream flow has been diverted and there is less natural flushing action from the tides and currents that normally cleanse coral reefs.

Marine Debris and Pollution
Man-made trash in the ocean, or marine debris, is harmful to reefs and marine life. Marine debris enters the ocean from ships and from land, where it is washed out to sea via rivers, streams and storm drains. Litter, abandoned and discarded fishing gear such as monofilament line, buoys, gill nets and traps, can collect, entangle, and damage coral and marine mammals and turtles, cutting into them, wounding them, and ultimately killing them. What's more, plastic doesn't easily degrade and can harm seabirds and other marine life for years or even centuries. Land-based sources of pollutants, such as sediment, nutrients, pollutants, products, pesticides, and sewage also threaten ocean life.

Alien Species
A host of invasive species (bamboo, Hawai‘i corals, alien algae, seaweed, coral fish, and other foreign organisms) intrude into our out-compete native species for food and space. Alien algae already dominates Kane‘ohe Bay and O‘ahu’s south shore, as well as the south shores of Kaua‘i, Molokai, and Maui. Ships from around the world bring alien marine species to Hawai‘i on their hulls and in their ballast water. When exotic fish from these saltwater environments come into the ocean, they can cause problems.

Alien algae already dominates Kāne‘ohe Bay and coastal marine reefs on O‘ahu’s south shore. Kane‘ohe islet is in the background. Corals can survive if the bleaching is brief, but not if it is prolonged. The bleaching can occur when a coral reef experiences a change in seawater temperature due to global warming, exposure to air or pollution, or a change in salinity content. This bleaching causes the corals to lose algae that provide them with nutrition. Corals can survive if the bleaching is brief, but not if it is prolonged. Thus far, Hawaii’s corals have recovered from brief episodes of coral bleaching. But if the trend in rising water temperatures continues, any future damage could be permanent.

Natural Disasters
Coral reefs are subject to damage from storms, high wave action, unusually heavy rains (which cause shallow reefs to be inundated with fresh water), and extreme low tides. Lethally cool reefs can usually recover from a natural event such as a hurricane or a heavy storm. However, the addition of human-created stresses can severely diminish their ability to survive.
Our reefs. Unfortunately, our reef resources are becoming increasingly scarce—public goods.

Some natural resources are classified as public goods, things that we all share and feel entitled to use for free—such as our beaches and shoreline life. As a natural resource, they have proven inadequate, and are often taken only what they needed, we lack effective incentives society has instituted rules regarding use of the ocean’s resources. As a result, many of our reefs are now severely depleted. Unlike traditional Hawaiians, whose heritage, way of catching only what we need and caring for ocean resources, they make difficult choices about our unique marine assets because Hawaiians’ coral reefs generate more than $570 million of economic annually in tourism, fishing, recreation, research, and other uses. By comparison, investment in understanding and exploiting the growing demands on our reefs is limited. Given that our reefs are the natural and economic assets on which our lifestyle, our economy, and our cultural heritage depend, many communities and natural resource on which their lifestyles depend. Many communities and natural resources’ Makai Watch program, informing snorkelers, boaters, and other ocean users of ocean resource violations often go undetected and unpunished. A renewed commitment to resource enforcement. The taking of a female lobster out of season or the killing of an endangered sea turtle or monk seal results in fines. For a state with the nation’s fourth longest coastline, Hawaii’s enforcement capacity is understaffed.

Hawaii’s enforcement capacity is underfunded and understaffed. The results is that natural resource management is ineffective, enforcement violations are often undiscovered and unpenalized. A renewed commitment to resource management must go hand in hand with a renewed commitment to marine resource enforcement.

Invest Onshore to Protect Offshore

In March 2006, lack of sewer maintenance and limited capacity led to the dumping of as much as 50,000 gallons of sewage per day into the Wai‘anu, where it quickly flowed into the waters off Waikiki. While news of this huge waste gave public anger in places in Hawaii, and our impacts are degrading our water, dumping waste,27 or other causes can degrade our reef systems. Without proper waste treatment facilities and an integrated system for preventing other land-based sources of shoreline pollution. You can do your part by taking steps to ensure our system is installed and functioning properly, using non-toxic cleaners and detergents, properly disposing of toxic chemicals, outdoor barbeques, and other outdoor activities. Stop the influx and spread of aquatic invasive species. Invasive marine species in our oceans are causing immeasurable harm to our natural resources, human health, and economy. At least 36 species of algae, 34 species of marine fish, and 267 invertebrate species have been introduced to Hawaii, some purposely to feed fish and some accidentally (e.g., through hull fouling and in ballast water).

The choices we make about our unique marine assets will determine our on-ramp to sustainability and rapid response to invasive aquatic species. Eutrophication, excessive growth of algae, is caused by nutrients from fertilizers, sewage, or other sources of nutrient pollution—ol it flows to the sea. If we want to protect and restore our reefs, we need a system of stringent enforcement and effective waste treatment facilities and an integrated system for preventing other land-based sources of shoreline pollution. You can do your part by taking steps to ensure our system is installed and functioning properly, using non-toxic cleaners and detergents, properly disposing of toxic chemicals, outdoor barbeques, and other outdoor activities.

Protecting a Priceless Natural Asset

With a resident population of 1.3 million and 7 million tour visits annually, the number of people making demands on our reefs is now far exceeds what our reefs can provide in terms of the resources. Our islands are taking the brunt of the pressure on our reefs. Although our society has instituted rules regarding use of the ocean’s resources, they have proven inadequate, and are often taken only what they needed, we lack effective incentives society has instituted rules regarding use of the ocean’s resources. As a result, many of our reefs are now severely depleted. Unlike traditional Hawaiians, whose heritage, way of catching only what we need and caring for ocean resources, they make difficult choices about our unique marine assets because Hawaiians’ coral reefs generate more than $570 million of economic annually in tourism, fishing, recreation, research, and other uses. By comparison, investment in understanding and exploiting the growing demands on our reefs is limited. Given that our reefs are the natural and economic assets on which our lifestyle, our economy, and our cultural heritage depend, many communities and natural resource on which their lifestyles depend. Many communities and natural resources’ Makai Watch program, informing snorkelers, boaters, and other ocean users of ocean resource violations. They then work to ensure compliance with those laws and chart the progress of their efforts, monitoring human use and biological change over time. In its first year, the Makai Watch program attracted the interest of nearly 30 communities. Their efforts must be encouraged through supportive state laws and funding. To start or join a Makai Watch program in your coastal community, go to the DLNR website.

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A Track Record of Success

Pohnpei, Federated States of Micronesia

When government officials in Pohnpei established seven marine reserves in 1997, the idea did not have community support. But now our community began seeing increased fisheries as a result of setting aside their fishing area. Other areas saw similar success. Studies of community-based reserves showed that less than two years after the closure, the average biomass of selected species increased by 50%, respectively, while populations of the reserves were 45% less than that of the control area. Today, Pohnpei’s 10 marine reserves, including all seven of the originally designated areas, have a total area of 96.5 square miles.

Two years after establishing Marine Reserves in Guam, fishermen reported seeing fish species they hadn’t seen in years. In two of the five areas designated as reserves, fish populations increased by 30% and 50%, while the overall diversity of fish species increased in all five areas.

Kona Coast, Hawaii

In 1996, the State of Hawaii set aside 50% of the Kona coastline as Marine Reserve areas – a move designed to establish a safe haven for local marine populations. Since the establishment of the reserves, fish populations have increased by 80% and populations of yellow tangs, which are up 100%. Also up were the number of local fishermen, as they now collecting more fish and making more money in west Hawaii than ever before.

Short-term Closures Do Not Work

Science and experience have shown that short-term closures are not successful in replenishing fish populations. Over the long term, for example, the Washi Channel Marine Fishery Management Area. Under the closures in the past, the fish in this area is closures, fish populations are immediately offset when the area is reopened following the year. More disturbing is the data that indicates that the fish biomass both current and abundance of fish within the Fishery Management Area is actually getting worse over the long term.