Excerpt from "Gyre: The Plastic Ocean"
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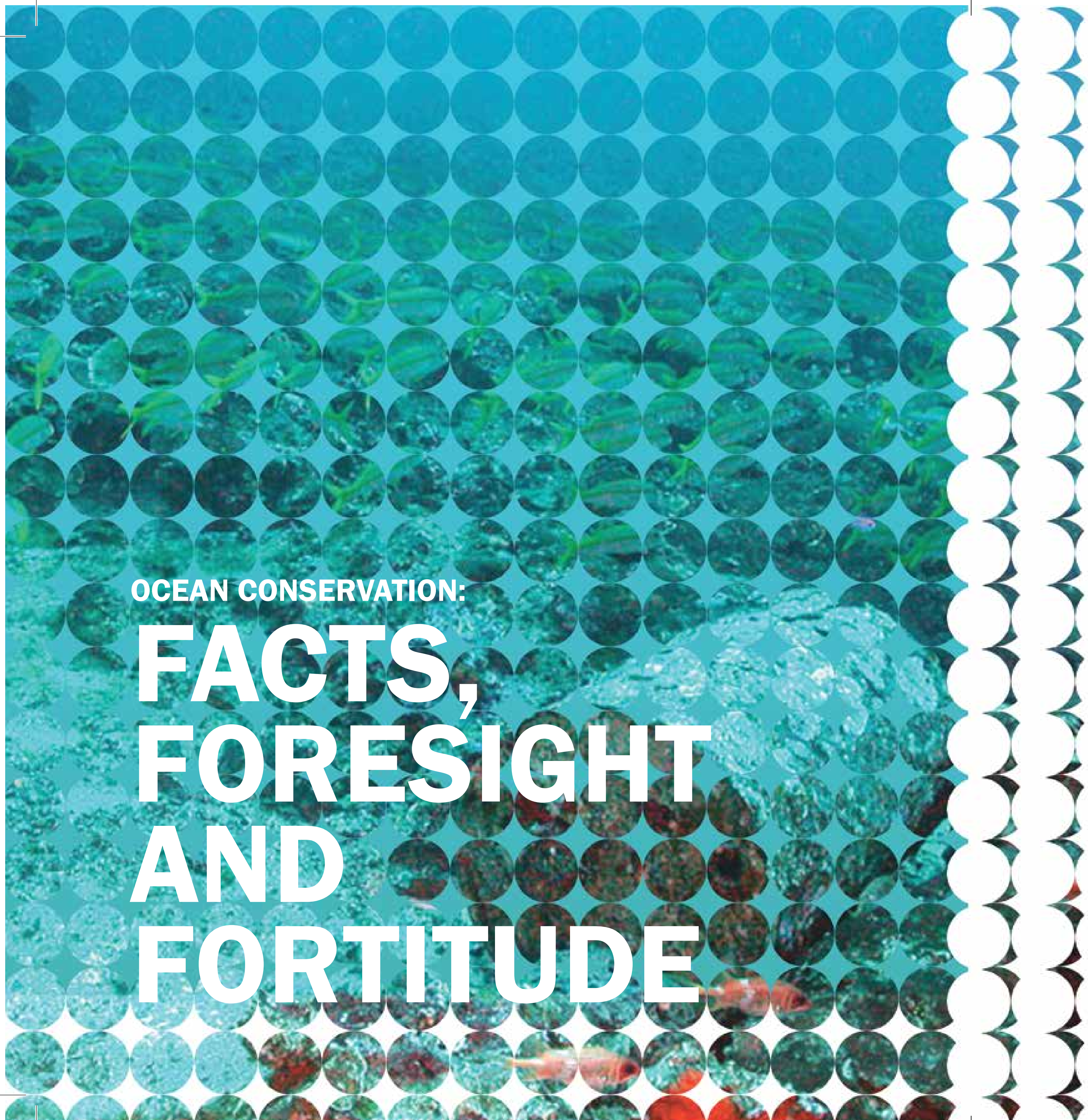

OCEAN CONSERVATION: FACTS, FORESIGHT AND FORTITUDE

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In the 1950s, I was a young boy who loved the beach. I watched the vast horizon stretch to the sky and let the reckless ocean surf chase my sunburned feet. I dug in the sand of the East Coast beaches for mole and sand crabs. A few years later, as a surfer, I evaluated wave sets, felt the buoyancy of saltwater, and anticipated storms and the long shore drift, undertow, and force of the water.

At that time, I wasn't thinking about climate change and sea level rise, coastal erosion or the changing beach gradient and orientation. I wasn't thinking about the impacts of trawlers and draggers. I wasn't aware of the relationship between fossil fuel combustion and increasing carbon dioxide concentrations in our atmosphere. And I didn't even know what an ecosystem was. I didn't appreciate how vital healthy oceans were to our lives and prosperity.

In the 1960s and 1970s, countering conservation discussions and advocacy to end water pollution, the catchy slogan "the solution to pollution is dilution," suggested limitless oceans. This view made it easy to ignore how our personal actions had growing impacts on our ocean.

We are now beginning to understand the many impacts of human behavior on our marine ecosystems. We stand before a battery of monumental challenges that will require foresight and fortitude to confront. Ocean conservation is the protection and preservation of ecosystems in oceans and seas. It is a multidisciplinary action designed to integrate biological, chemical and physical oceanography, and to evaluate human impacts, including growing populations and food security, economic enterprise models, fisheries management policy, and emerging strategies such as marine protected areas and marine spatial planning. Ocean conservation is designed to advance ocean health.

One of the many monumental challenges we face is ocean acidification. We know that oceans absorb carbon dioxide. Human activity, including combustion of carbon-based fuels, has elevated the carbon dioxide concentration in our atmosphere, which has a direct

TRASH BARREL ON OCEAN FLOOR
Photograph by Kip Evans

relationship to the absorption of carbon dioxide in our ocean. Dissolution of carbon dioxide in water creates carbonic acid that transforms to carbonate and predominantly bicarbonate ions, which means less carbonate is available for shellfish to generate shells. Some of the shells of concern are those of pteropods, which are small planktonic mollusks at the bottom of the marine food chain and that are a key food source for many other species in our oceans. Since the start of the industrial revolution, oceans have absorbed over 120 billion tons of carbon dioxide.[1]

Oceans might seem limitless when standing on a beach viewing the horizon toward space but, with the growing human population, consumption, waste, and technology, they are a finite resource. Instead of thinking about our oceans as separate water bodies based on bordering landmasses, we must think of our oceans as one volume of water—a global ocean. Activities in one part of the world, either in the ocean or the atmosphere, can contribute to outcomes in another part of the world. This is an important concept when discussing marine debris as a global ocean conservation priority.

We must also understand human population scale and growth in order to tackle ocean resource sustainability. In the last 200 years, the global human population has experienced exponential growth. This growth was fueled by technological advances and improved health standards, which led to increased human survival, industrialization of food supplies and food distribution, and increased extraction and use of natural resources. We see over that time the demand a growing global population has had on extracting protein from the global ocean. Our record of large fish harvests is a record of depletion. Only 10% remains of the biomass of all large fish species such as tuna, swordfish, marlin, and large ground fish such as cod, halibut, skates, and flounders.[2] Sharks have been swimming the global ocean for 400 million years, yet 32% of the open-ocean or pelagic shark species are threatened with extinction largely due to overfishing and by-catch.[3] The depletion of large apex predators could have significant cascading effects on marine ecosystems. The record of depleted fish species is also exemplary of cropping down the food chain. As we eliminate or reduce large species, we shift to harvesting smaller species nested further down the food chain or food web. Our capacity to continually extract fish (and historically, mammals) from the sea exceeds the rate, and hence capacity, of the sea to reproduce on our demand timescale.

Effective fishery regulation and management, such as the Magnuson-Stevens Fishery Conservation and Management Act, encourages sustainable fisheries practices at the national and regional levels. Still, biodiversity continues to diminish.[4] Species that once thrived with larger spawning adults have been selectively harvested so that now only smaller fish are found, resulting in an up to 35% decrease in stock biomass and, in many cases, increased predatory mortality.[5] We decimate benthic habitats and species by drag fishing.[6] In areas of the global ocean where fish protein is in demand, dynamite has been used to harvest fish, which also damages habitat, impairing the area to support fish and invertebrate populations.

With the increased demand and utilization of resources, comes an ever-increasing waste stream. We have sufficiently polluted regions of the world ocean through watershed runoff of various pollutants to create dead zones. In 2004, the United National Environmental Program reported 146 dead zones in the world's oceans. In 2008, that number had increased to 405. Dead zones are caused by an increase in chemical nutrients, a process called eutrophication, that boosts production and decomposition of phytoplankton leading to a depletion of dissolved oxygen. Not all dead zones are caused by human activities. Some dead zones are the result of natural upwelling of nutrients, although chemical fertilizer runoff and sewage discharge are increasingly responsible.

Pollution or nutrient runoff is also contributing to the destruction of the earth's coral reefs. Coral reefs are structures made from calcium carbonate secreted by colonies of tiny animals. These reefs are found in areas where nutrient concentration is low. Siltation and algal growth caused by human activities, watershed runoff and nutrient waste can smother coral. Additionally, coral mining, dynamite blasting to kill fish, sea temperature increases associated with climate change, sea level rise and ocean acidification all can play a role in coral reef impairment or destruction. Scientists estimate 10% of the world's coral reefs are now dead and 60% are at risk due to human activities. We also know that coral reefs are home to more than 25% of all marine species, which are then also at risk.

STAND OF ELKHORN CORAL IN BELIZE
Photograph by Kip Evans

Given these facts and competing forces, we must step up our efforts to moderate actions that damage the health and balance of marine ecosystems and their functions. It is reassuring to know that many nations, organizations, and individuals are engaged in this effort to examine the causes of the many threats to the global ocean commons. Across the spectrum of battlefronts, efforts to advance global polices on managing behaviors and ocean resources continue to mature—everything from improvements and innovations in technology to target harvested species, to reduction of by-catch of less marketable or harvest restricted species,[7] to scientific advances to assist wise resource management decisions such as ecosystem-based fisheries management.[8] Even in impoverished economies, where people once overexploited local marine resources, people now embrace their local marine ecosystems as sustainable treasures, rather than pillaging them for short term and finite gain.[9]

While progress is being made on some fronts of ocean conservation, new threats emerge—most notably, marine debris. Defined by the National Oceanic and Atmospheric Administration (NOAA), marine debris is any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes. Resulting in global and diverse impacts, marine debris as a converging topic provides a framework to discuss many facets of ocean conservation.

Marine debris is predominantly composed of plastic. It is generally acknowledged that marine debris is now 60-80% plastic, reaching 90-95% in some areas.[10] Marine debris is a generic term covering items such as liquid containers, cigarette butts, monofilament line, plastic bags, needles, flip-flops and the thousands of other products and by-products of our invention. Marine debris also includes derelict fish and crab traps, munitions dumped at sea, abandoned fishing nets and fish aggregating devices. In addition to individual items lost or discarded that are found as debris, it has been estimated that less than 1% of cargo containers shipped annually are lost at sea—not a large percentage, but, in actual numbers, up to 10,000 cargo containers[11] are lost annually from ships.

The scope of issues we face with marine debris parallel and complicate other ocean threats. Debris may contribute to entanglement and trapping of many species of crustaceans, mammals, fish and birds already depleted through directed harvest, by-catch, or loss of habitat. For example, ghost nets may continue to ensnare, trap, and kill numbers of fish long after the nets are lost or discarded. According to the Institute for European Environmental Policy (2005), Baltic Sea ghost nets may be responsible for 4-5 percent of the commercial level harvest after 27 months.[12] In more severe cases, data about deep water fisheries in the northeast Atlantic suggests that the catching efficiency of ghost nets stabilizes at 20-30 percent of commercial catch rates after 45 days and that some nets may continue to catch lesser amounts for more than eight years after being lost. They also report that in the deepwater fishery in the northeast Atlantic, "around 25,000 nets may be lost or deliberately discarded each year, with a total length of around 1,250 km." In a study of derelict blue crab traps, 25,000 derelict crab traps were removed and documented from Virginia waters between the years 2009-2011, many still actively killing crabs.[13] With annual trap losses estimated at 30% in that fishery, an additional 100,000 derelict traps may be added to those already lost and actively killing not only blue crabs, but Atlantic croakers, oyster toadfish and white perch. Millions of organisms are potentially lost each season given that experimental traps show 50 crabs captured per season.

Marine debris is both macro and micro in scale, so the mechanisms of impact vary from large-scale entanglement to micro-scale plastic items that are ingested, causing injury and death. Birds, fish, sea turtles and marine mammals are all impacted by entanglement in plastic products and ingestion of plastics. As we learn more about plastics in the marine environment, new areas of concern emerge including nanno plastics and manufactured micro plastics used as exfoliants in cosmetics. Research is beginning to shed light on micro plastic particle impacts[14] and how high concentrations of hydrophobic organic contaminants are known to be associated with plastics in the marine environment, which may impact animals upon ingestion.[15] Ultimately, humans are a top consumer of marine organisms and may also be the final repository of many of the accumulating plastic by-products and associated chemicals.

We must confront the challenges of plastic, the expanding waste of our culture that enters the global ocean. Plastics are synthetic, and they are aggregating on our beaches and in our global ocean at an astonishing rate and with high volume. Human population scale, global economic growth, universal adoption of plastic as an inexpensive, durable, lightweight, versatile material for thousands of products, adoption of many single-use products, and few repurposing or recycling options globally, results in monumental production of plastic waste. Much of this plastic is finding its way directly or indirectly into our global ocean.

People of our global ocean are mobilizing for these challenges. The 5th International Marine Debris Conference held in 2010 is evidence of both the problem and the emerging global efforts to stem the tide of plastic marine debris. Representatives from more than 40 nations were present at the conference convened jointly by the National Oceanic and Atmospheric Administration (NOAA) and the United Nations Environmental Program (UNEP). As a result of the conference, the Honolulu Strategy was developed, which serves as a framework for a comprehensive and global effort to reduce the ecological, human health, and economic impacts of marine debris globally.[16]

We need to sustain the global ocean for future generations. Marine debris is a solvable problem. Human foresight and fortitude are needed to enter a more hopeful future.

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BUOY FOUND ALONG THE COAST OF MONTAGUE ISLAND, ALASKA
The island, in the Gulf of Alaska and at the entrance to Prince William Sound, has been subject to unprecedented amounts of ocean trash transported by wind and currents from Japan's March 2011 tsunami. Photograph by Tim Remick