Coral Reefs & Climate Change:

Last Straw for a Threatened Ecosystem

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NATIONAL WILDLIFE FEDERATION®

Forward

Whether you like to swim, snorkel, scuba, fish, or sail, or a photograph has caught your eye while leafing through a magazine, almost all of us have had an encounter with our world's exotic and colorful coral reefs. In this new report, ***Coral Reefs and Climate Change: Last Straw for a Threatened Ecosystem,*** the National Wildlife Federation presents the latest information about coral reefs, the rich and abundant habitat they create for thousands of wildlife species, and the incredible fishing and tourism opportunities they afford to local communities.

Coral reefs are extremely important to people and wildlife. They are home to more than one-quarter of all marine wildlife species. They also protect coast lines from storms and erosion, and form the foundation for thriving tourism and fishing industries that contribute millions of dollars to local, state and regional economies.

Current research, however, reveals an alarming fact: global climate change now joins dredging, pollution, over-fishing and harmful fishing practices as one of the major factors that imperil more than 60 percent of the world's coral reefs. Science shows that the effects of the mostly human-induced degradation on the world's coral reefs are already dramatic; the "coral bleaching" that has received so much press is only one of the tell-tale signs that these vibrant ecosystems are being pushed too far. The new threat of global climate change may be the proverbial last straw for the Earth's coral reefs.

The National Wildlife Federation's Climate Change & Wildlife Program provides concerned citizens in communities throughout the country the education and tools they need to understand global climate change and advocate for responsible policies to address it. The program is giving special attention to climate change's impact on coral reefs. Their delicate structure makes them especially vulnerable to the effects of global warming and gives us a glimpse into what the future holds for other ecosystems, if global climate change remains unchecked.

While the stakes are extremely high, the good news is that we have tremendous opportunities to help restore and conserve the world's coral reefs in our everyday activities, as described in the following pages. We hope this publication will create an appreciation of how important our reefs are to people and wildlife, and inspire all those concerned to help slow global climate change and address the other threats to these unique and beautiful ecosystems.

Mark Van Putten
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Introduction

Little can compare to the natural beauty and rich biological diversity of the world's coral reefs. From the Great Barrier Reef ecosystem "down under" to the series of reefs off the Florida Keys, these colorful "rainforests of the sea" are home to thousands of marine species — one of every four ocean species known. Their structures help protect coasts from erosion and storm damage. And they support a fishing and tourism industry worth hundreds of billions of dollars globally.

Unfortunately, these glorious ecosystems are under siege by human activities. Increasingly, the world's reefs are being ravaged by dredging and coral collecting, poisoned by pollution and cyanide, and depleted by over-fishing. Furthermore, the evidence is mounting that global warming — the result of extensive use of fossil fuels and destruction of the world's forests — is dealing these already weakened ecosystems a serious blow.

Without a concerted global effort to protect and restore coral reefs from all of these threats, we stand to lose more than just an important resource — we will lose one of nature's crown jewels and a fundamental part of our oceans' ecological vitality.

The National Wildlife Federation (NWF) has produced this report to help you learn more about the threats to coral reef ecosystems and what all of us can do to save these natural treasures, for the benefit of people and wildlife alike!

How Does a Coral Reef Ecosystem Work?

As with all ecosystems, the health of a coral reef ecosystem depends on a complex, dynamic relationship between wildlife species and their environment.

At the foundation of the reef ecosystem is the interrelationship between coral polyps, an invertebrate marine animal, and zooxanthellae, tiny plants called algae that live inside the corals (Wilkinson and Buddemeier, 1994). Coral polyps provide the algae with nitrogen and phosphorous (waste products from the corals' digestion of plankton and other foods) and carbon dioxide (CO_2) from the corals' respiration, which the algae needs for photosynthesis. In return, the algae provide coral polyps with oxygen, nutrients, and their characteristic color (it is the algae that are pigmented, not the coral themselves). This symbiotic relationship also helps corals sustain high rates of calcification (the production of calcium carbonate), which forms their protective "skeletons" and is the fundamental building block of coral reefs.

Together, the corals and algae depend on a highly specific environment (although there is some degree of variability among certain species and regions). Generally, coral reefs need:

- Warm, relatively consistent water temperatures (coral reefs generally grow best between 77 to 84.2 degrees Fahrenheit, only a few degrees below their upper thermal limit, although the absolute range may be between 64.4 and 91.4 degrees Fahrenheit for some corals) (Wilkinson and Buddemeier, 1994, p. 89);
- Shallow, clear water to provide regular sunlight for photosynthesis (maximum rates of growth and productivity occur between 16.4 to 49.2 feet) (Hopley and Kinsey, 1988; Wilkinson and Buddemeier, 1994, p. 13);
- Low levels of sedimentation, too much of which can restrict sunlight and smother the corals (Chou, 1991);
- Relatively low levels of organic and inorganic nutrients (corals receive much of what they need from their symbiotic algae);
- Consistent salinity [optimally about 35 parts per trillion (ppt), with a range between 25 and 40 ppt] (Wilkinson and Buddemeier, 1994, p. 13); and
- Shielding from excessive UV-B radiation, which can damage corals' DNA.

Within this environment, coral reefs provide food and/or shelter for a plethora of marine species. Fish of many shapes, colors, and sizes congregate in and around reefs, as do hundreds of species of marine invertebrates. Other species, such as marine birds and mammals, rely on reef ecosystems for sources of food. In all, the coral reef ecosystem is one of the most biologically rich on the planet (Doubilet, 1999).

Coral reefs also provide many benefits to humans. Healthy reef ecosystems support a global fishing industry worth billions of dollars, and some developing countries rely on reef fisheries for virtually all of their animal pro-

One of the greatest problems facing reefs today is the increasing development of coastal areas.

tein consumption. Reefs also protect coasts by reducing storm damage and erosion due to intense wave action. And many regions depend on nearby coral reefs for a thriving tourism industry. The reefs off the Florida Keys, for example, help generate more than $1.6 billion in revenues for the region each year (Birkeland, 1997).

Paradoxically, the coral reef ecosystem that is so important for both people and wildlife is also among the world's most fragile. The specialized nature of coral reef ecosystems makes them particularly vulnerable to changes in environmental conditions. Sewage runoff from coastal developments, for example, raises nutrient levels in the coastal waters and can lead to algal blooms, blocking critical sunlight and slowing coral growth. Dredging stirs up sediments and alters tidal flows, damaging reefs and smothering corals. Global climate change could affect all of these environmental factors, either directly or indirectly, by increasing average water temperatures, increasing storm runoff into coastal waters, and raising sea levels. Each and all of these threats can alter the dynamics of the coral reef ecosystem, with far reaching consequences.

Current Threats to Coral Reefs

It is estimated that close to 60 percent of the world's coral reefs are already severely threatened by a number of human-induced stresses, including coastal development, pollution, and harmful fishing practices (Bryant et al., 1998).

Coastal Development and Pollution

One of the greatest problems facing reefs today is the increasing development of coastal areas (Wilkinson and Buddemeier, 1994; Bryant et al., 1998).

Coasts have long been a center for human activity. Nearly half of the population in the U.S. lives within coastal counties. Worldwide, coastal areas provide humans with a bounty of natural resources, access to transportation, and a place of solace and recreation. Unfortunately, we have historically exploited the world's coastal areas with little regard for the fundamental health of the environment that provides us with all of these resources, including coral reefs.

As we dredge channels for ship navigation, we destroy the reefs that help protect shores from erosion. When we build structures and pave over coastal vegetation, we enable polluted runoff and silt to flow into the ocean and degrade water on which reefs, and the species they support, depend. In the U.S. Virgin Islands and other areas of the Caribbean, for example, rapid development over the past 50 years has contributed to excessive sewage runoff, which harms coral reefs by causing accelerated algae growth. Even inland, mining, agriculture, deforestation, and fossil fuel combustion send pollutants and silt through the air and down rivers and into the oceans, poisoning marine animals in the process. For example, researchers have found that siltation from deforestation in both Central and South America has adversely affected reefs throughout the region, and unhealthy water quality has been compounded by herbicide and fertilizer runoff (Jameson, 1995).

Over-Fishing and Harmful Fishing Activities

Humans have long exploited reefs for the abundance of seafood and other resources that they provide. Their proximity to land makes coral reefs highly accessible, and the variety and volume of species they support in a relatively small area have historically made it easy for fishermen to reap enormous catches.

There is growing evidence, however, that many of the world's reef-supported fisheries have been harvested unsustainably, with more fish and other species being taken from the sea than the areas can reproduce. In some places, over-fishing has even led to local extinction of certain reef-dependent species, such as the sea urchin and sea cucumber in reefs of the western Caribbean (Bryant et al., 1998). As species disappear from the reef habitat, the dynamics of the entire ecosystem can change. For example, a decrease in the number of algae-eating species in the Caribbean led to explosive algae growth among reefs in the region in the early 1980s. In some areas, coral cover has dropped considerably as a result of being smothered by the algae (Wilkinson and Buddemeier, 1994).

Coral reefs are also being damaged by harmful fishing techniques. For example, fishermen in Indonesia and the Philippines frequently use cyanide to stun and catch the colorful marine fish that congregate near reefs, a practice that is harmful to corals, invertebrates, and other species that rely on the reef ecosystem (Bryant et al., 1998). They then sell their catches to high-paying aquarium hobbyists and specialty fish shops around the world, especially the U.S. While the practice of cyanide fishing is illegal in most places, the businesses it supports are highly lucrative — the aquarium industry sells $200 million worth of live salt water fish and coral worldwide each year. As a result, the pressure to continue this method of fishing persists (Chadwick, 1999).

In other regions of the Pacific and southeast Asia, fishermen use dynamite around reefs to kill fish in great quantities, damaging reefs and harming other species in the process. Even the corals themselves are mined for building materials and other uses.

What Can We Do?

There are a number of things we can do to help protect coral reefs from the ravages of these localized threats. For example, we can:

1. Establish and strengthen local and national policies and programs to improve coastal water quality and protect reef-dependent watersheds.

Protecting water quality, both along coasts and inland, is key in ensuring a healthy environment for coral reef ecosystems. NWF is committed to protecting the nation's water quality through saving and restoring important watersheds. To learn more about our water quality activities, contact Tim Eder at NWF's Great Lakes Natural Resource Center in Ann Arbor, Michigan, (734) 769-3351, eder@nwf.org. Or you can check NWF's Website at www.nwf.org/water.

In addition, a number of Federal agencies have joined together to develop a national Clean Water Action Plan to speed the restoration of the nation's waterways by strengthening public health protections, targeting community-based watershed protection efforts at high priority areas, and providing communities with new resources to control polluted runoff. For more information, you can call the EPA's Office of Water (one of the lead agencies) at (202) 260-5700 or you can refer to the program's Website at www.cleanwater.gov.

2. Expand marine protected areas around reefs here in the U.S. and collaborate with other nations to promote such efforts in their regions.

Including coral reef ecosystems as part of the global series of marine protected areas (MPAs) provides one of the greatest hopes for their long-term survival (Bryant, et al., 1999). Only a few of the world's major reef ecosystems, such as the Great Barrier Reef and the Florida Keys National Marine Sanctuary, have received relatively broad protection status (and are therefore managed with their overall health in mind). Most of the world's reefs, however, are inadequately protected — if at all. And since reef ecosystems cannot be fenced off, even "protected" marine habitats face threats from external sources, such as over-fishing, pollution, and climate change. We must therefore work to incorporate greater consideration of these problems by expanding MPAs and developing more comprehensive management plans, both in the U.S. and internationally.

The National Oceanic and Atmospheric Administration (NOAA) is responsible for a wide range of coastal protection activities, including the management of 12 National Marine Sanctuaries and 22 National Estuarine Research Reserves (which are co-managed with state partners). NOAA can be reached at (202) 482-6090, or you can check their Website at www.noaa.gov for more information.

On the international front, a good place to start for more information is the Bureau of Oceans and International Environmental and Scientific Affairs at the U.S. Department of State. You can contact that office at (202) 647-3486 or refer to their Website at www.state.gov.

3. Increase federal funding for coral reef research and restoration.

Federal support for collaborative coral reef research and conservation activities will help us develop a better understanding of how these important ecosystems work and ways in which we can restore and protect them. Ongoing research by NOAA, for example, has played a major role in both assessing the current status of U.S. reef systems and implementing strategies to better manage them. Continued funding for this and other like-minded agencies will ensure that such work continues.

For more information on what you can do to support funding for coral reef protection, contact Jodi Applegate or Sara Barth at NWF's Office of Federal and International Affairs in Washington, D.C., (202) 797-6800, applegate@nwf.org or barth@nwf.org, or check NWF's Website at www.nwf.org/naturefunding.

4. Discourage trade in marine species that have been captured through damaging or unsustainable techniques.

There are a number of things we can do to ensure that a healthy environment does not take a back seat to short-term economic gains. For example, we can work to pro-

mote certification programs to discourage the sale of fish in our local pet stores that have been caught through cyanide fishing techniques. And we can promote the incorporation of sanctions or other mechanisms in international trade rules to eliminate commerce between nations that engage in illegal fishing practices. Ultimately, such strategies will benefit both the environment and the global economy.

NWF has an ongoing program dedicated to incorporating environmental concerns into international trade laws. To find out more about this effort and how you can help, contact Jake Caldwell at NWF's Office of Federal and International Affairs, (202) 797-6800, caldwell@nwf.org, or check NWF's Website at www.nwf.org/international/trade.

Healthy coral

Bleached coral

Reefs and Global Climate Change

Reducing the localized threats to coral reefs will go far in protecting these important ecosystems today. It will also help them have a fighting chance against what may well be their greatest threat in the coming century — global climate change.

Scientists are now certain that human activities — in particular the burning of fossil fuels and destruction of forests — are causing an excess amount of greenhouse gases to build up in the atmosphere and are accelerating global warming. Atmospheric concentrations of carbon dioxide, the primary greenhouse gas, have risen nearly 30 percent in the last 100 years — after the onset of the Industrial Revolution. The average global temperature has risen one degree Fahrenheit over the same period. The ten warmest years in the past 100 have occurred since 1980. And July 1998 set a new record for global temperature (NOAA, 1999).

The world's top scientists have concluded that this global warming is disrupting the Earth's climate, altering regional temperatures and precipitation patterns, causing a rise in sea level, and possibly increasing the severity of storms (IPCC, 1995). While it is very difficult to predict specific events on a global scale, scientists project that habitats could change and subsequently many species could be affected, including corals and the thousands of species that live in the ecosystem they help create (IPCC, 1998).

Higher Temperatures and Coral Bleaching

One of the most striking signs that climate change may already be happening is the growing incidence of coral bleaching, which is due in part to the prolonged exposure of corals to warmer-than-normal water temperatures (Wilkinson, 1998; Karlo, 1993; Roberts, 1993).

While corals normally rely on warm water for their survival, water that is too warm can cause them to lose the "zooxanthellae," a type of algae, that they host. Without the colorful algae, the corals appear white, or "bleached," since you can see the coral skeletons through the transparent tissue of the live corals. Since zooxanthellae provide corals with nutrients, a lack of the algae causes the corals to starve. Although corals can often recover from bleaching, they will die if the stress is extreme or prolonged (Wilkinson, 1998).

In 1998, high sea surface temperatures, brought on by the year's record El Niño, caused extensive bleaching throughout the Caribbean and in the reefs of the Pacific and Indian Oceans. In areas off the Florida Keys, for example, natural resource officials reported that as much as 90 percent of some coral species had died (Wilkinson, 1998). Other regions experienced similar events (see Box 1).

Although there is a strong correlation between El Niño events and coral bleaching, El Niño alone cannot explain the recent bleaching patterns that have been observed across the globe (Pomerance et al., 1999). Of particular concern is the significant increase in the number of massive bleaching episodes since the late 1970s, corresponding with increasingly warmer global temperatures. Given this, researchers are beginning to look at coral reefs as early indicators of climate change.

Major Coral Bleaching Events Reported in 1997-1998

Catastrophic bleaching with near 95% mortality:

Bahrain, Maldives, Sri Lanka, Singapore, Tanzania

Severe bleaching with significant mortality (50 to 70%), with recovery of some larger, more resistant species:

Kenya, Seychelles, Thailand, Vietnam, Japan, Belize

Severe bleaching in some reefs, with a mix of mortality (around 20 to 50% in places) and some recovery:

Oman, Madagascar, parts of the Great Barrier Reef, parts of Indonesia and the Philippines, Taiwan, Palau, French Polynesia, Galapagos, Bahamas, Cayman Islands, Florida, Bermuda, Brazil

Source: Wilkinson, Clive. "The 1997-1998 Mass Bleaching Event Around the World." Australian Institute of Marine Science (AIMS) Research (www.aims.gov.au), December 1998.

Higher Temperatures, Dust, and Coral Diseases

There has also been a rapid increase in the incidence, range, and intensity of coral diseases in recent years. While there are many factors that contribute to the spread of diseases among corals and other marine species, scientists are beginning to find a strong association between emerging diseases and climatic variables such as elevated sea surface temperatures and atmospheric dust due to widespread drought and overgrazing in some regions (Barber, 1999).

Growing outbreaks of black band and white band disease, coral plague, and Aspergillosis (a fungus) have led to massive, unprecedented die-offs among corals in many areas (Richardson, 1998). Since 1996, the number of reef monitoring stations in the Florida Keys that have exhibited signs of coral diseases has risen by a factor of four (Porter, 1999). Scientists attribute at least some of this increase to higher water temperatures, which can weaken corals (by causing them to bleach) and at the same time allow many pathogens to thrive.

There is also speculation that additional stresses, such as pollution and the deposition of dust in the oceans, might add to corals' vulnerability to some diseases. For example, recent research suggests that prolonged drought in the Sahel region of Africa has contributed to a significant increase in the global supply of iron-rich dust in the atmosphere. When some of the dust is transported to, and deposited in, the tropical oceans, it adds iron to the water and may contribute to the growth of a variety of organisms that are harmful to corals (Barber, 1999).

Sea Level Rise

Scientists predict that thermal expansion of the oceans and rapid melting of sea ice and glaciers, as a result of global warming, will cause sea levels to rise by 6 to 37 inches by the year 2100. At the upper range of scientific projections, sea level rise may cause some reefs to fall below what is considered their optimal water level.

Water that is "too deep," for example, can restrict the amount of sunlight that reaches the corals, making it more difficult for their algae to photosynthesize. It could also reduce the rate at which corals are able to calcify, which would not only make it more difficult for the reefs to "catch up" to the sea level rise, but it could also reduce their skeletal density, making them weaker and more vulnerable to storms. Finally, sea level rise in some areas could place reefs farther from the shore line and reduce their effectiveness in protecting coasts from erosion (Wilkinson and Buddemeier, 1994).

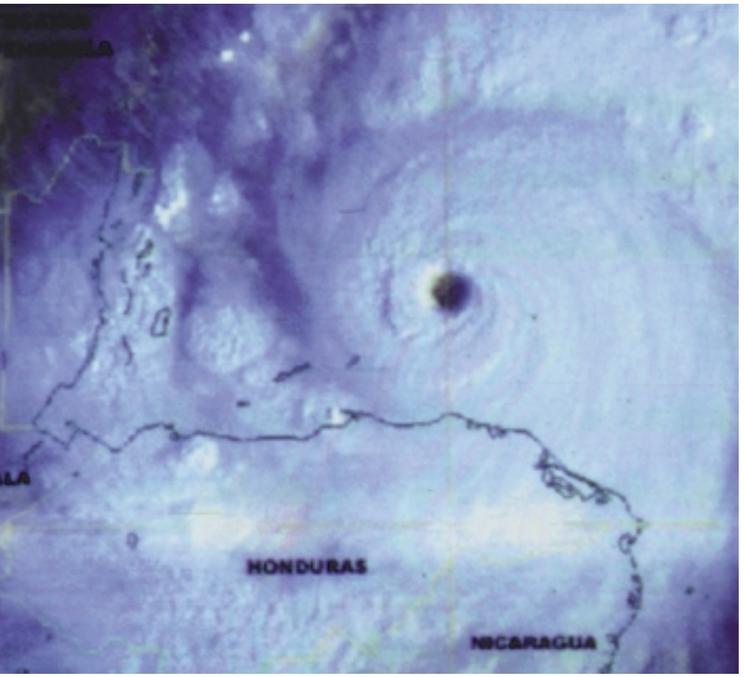
While healthy coral reefs have historically been able to withstand changes in sea level, reefs weakened by other stresses may be less resilient to significant sea level rise in the future.

More Severe Storms

Severe weather such as tropical storms and hurricanes, which scientists project may become more frequent as a result of global warming, can take a heavy toll on coral reefs. This is especially true where coastal development and other factors have diminished their resistance to heavy surf, storm surges, and runoff. For example, coral reefs off the eastern coast of Central America have been seriously damaged by the lingering effects of Hurricane Mitch, which hit Central America in the fall of 1998 and was one of the deadliest, most destructive storms in history (Gonzalez, 1999).

Tidal surges and contaminated runoff from the storm destroyed much of the region's coastal mangroves, which are responsible for anchoring sediment along the shoreline and filtering terrestrial runoff before it reaches the ocean. This filtering function is particularly important to the survival of coral reefs and to the many species and

human populations that depend on them. In particular, mangroves and coral reefs provide a vital nursery habitat for numerous species of fish and invertebrates, and their destruction has caused ripple effects throughout the ecosystem. By December 1998, just two months after



Hurricane Mitch, which hit Central America in the fall of 1998, was one of the deadliest, most destructive storms in history, and caused extensive damage to the region's reefs.

Hurricane Mitch struck, scientists were already beginning to see a significant decline in the region's shrimp population, a key component of the area's food web.

Elevated CO_2 Levels and Coral Growth

In addition to contributing to climate change, increased atmospheric concentrations of carbon dioxide may have a more direct effect on the health of coral reefs. Recent studies have suggested that rising levels of CO_2 in the atmosphere, some of which is absorbed by the oceans, is reducing the ability of corals to build up calcium carbonate, the substance that forms their protective skeletons (Gattuso et al., 1997; Kleypas et al., 1999; Buddemeier and Fautin, 1996).

Scientists have found that increased atmospheric CO_2 changes the carbon chemistry of surface ocean water and reduces the ability of some coral species to develop their protective shells (i.e., to "calcify"). In some regions, calcification rates among corals have decreased by an average of 6 to 11% as the chemistry of the sea water has changed. If CO_2 concentrations reach 600-700 parts per million (ppm) by the middle of the next century, scientists expect the rates will decrease by another 8 to 17% (Kleypas et al., 1999). The result is that coral reefs will grow and replenish more slowly than normal, making them vulnerable to other stresses.

What Can We Do?

In addition to protecting coral reefs from problems such as coastal development, pollution, and over-fishing, we should also learn more about how climate change is affecting these important ecosystems and help slow global warming by reducing emissions of greenhouse gases. For example, we should:

1. Support greater research and monitoring, including ongoing study of how changes in water temperatures and other climatic variables are affecting reefs and reef-dependent species.

The sensitivity of coral reefs to changing environmental conditions makes them important indicators of overall environmental health. Ongoing research and monitoring of reef ecosystems will continue to provide us with clues about how these ecosystems are changing and can help us identify ways to protect and restore them. In addition to the ongoing research of government agencies and scientific institutions worldwide, there are a number of non-profit organizations, such as the Reef Environmental Education Foundation (REEF), that have developed programs to teach amateur divers and snorkelers how to become actively involved in collecting marine data. We should work with each of these agencies and organizations to conduct ongoing assessments of such factors as:

- Water temperatures and coral bleaching;
- Incidence and range of coral diseases;
- Changes in the range of individual marine species;
- Identification of damage and recovery from storms, both immediately after the events and over time; and
- Assessment of water quality, including the calcium carbonate saturation state, and its effects on reefs over time.

For more information on how to expand coral reef monitoring, contact REEF in Key Largo, Florida, at (305) 451-0312, or check their Website at www.reef.org.

2. Work to reduce the threat of global climate change by promoting responsible national and international strategies to decrease greenhouse gas emissions.

To ensure that on-the-ground efforts to save the world's reef ecosystem endure, we must also work to curb global warming, beginning with action here in the U.S. Specifically, we should encourage our local and national policy makers to:

- *Set specific limits on global warming pollution from power plants.* Electric utilities currently account for more than one-third of U.S. carbon dioxide emissions. On the national level, cleaning up the nation's dirtiest, coal-fired power plants by switching them to cleaner-burning natural gas and, eventually, to renewable energy sources such as solar and wind will go a long way toward reducing the nation's greenhouse gas emissions. It will also help reduce more localized environmental problems such as acid rain, ozone pollution, and the deposition of mercury and nitrogen in our lakes, streams, and coastal waters — all very serious threats to human health, wildlife, and ecosystems.
- *Strengthen programs to promote energy efficiency and clean, renewable energy such as wind and solar power.* By cutting down on energy use and using energy more efficiently in our homes, businesses, and industries, we can help stretch limited resources, cut down on air pollution, slow global warming, and protect wildlife habitat. Significant improvements in energy efficiency are not only technologically feasible, but they make both environmental and economic sense. They slow CO_2 build-up and reduce other energy-related pollution. Investments in energy efficiency technologies also provide households and businesses with significant savings by lowering energy costs. For example, replacing one incandescent light bulb in your home with a compact fluorescent bulb prevents the emission of 1,000 to 2,000 pounds of carbon dioxide from power plants and saves you roughly $25-50 over the lifetime of the bulb (RMI, 1994).

Harnessing abundant renewable energy sources such as solar and wind power will also be critical to curbing global warming in the future. Continued investment in research and development of renewable energy and strong policy signals supporting their use will provide the world with a sustainable, environmentally sound source of energy in the longer term.

- *Raise fuel economy standards for all cars and trucks.* Cars and trucks are one of the single largest sources of greenhouse gas emissions. In North America, the average car produces more than 5 tons of carbon dioxide each year. They also contribute to acid rain, urban smog, particulate pollution, and the release of hazardous chemicals such as benzene into the atmosphere. By improving fuel efficiency, each vehicle will emit less CO_2 and other pollutants into the air for each mile it is driven.

One of the most important and effective strategies the U.S. can undertake to address global warming and other environmental problems stemming from our use of motor vehicles is to increase the Corporate Average Fuel Economy (CAFE) standards. To start, we should level the fuel economy playing field between cars, trucks, and sport utility vehicles (SUVs). Cost-effective technology is available today that can significantly increase the fuel efficiency of these vehicles without sacrificing space, power, or safety. And doing so will reduce greenhouse gas emissions, improve the quality of our air, and save consumers money at the gas pump.

Conclusion

We should all be concerned about the loss of the world's coral reefs, not only because of what their destruction due to human activities means for the health of our oceans' biological diversity, but also because of what it tells us about the broader problems we face from global climate change. The plight of the humble coral polyp invertebrate is nature's warning sign, a challenge to our higher intelligence that grave danger lies in store if we do not take corrective action. The rapid demise of coral reefs around the world provides a clear indication of how climate change is altering the world's ecology, with potentially devastating consequences for the human societies and wildlife that depend on it.

The good news is that it's not too late to help our reef ecosystems – *but we must act now.* Many of the strategies described above require national or even international action, sometimes including regulation or the expenditure of public funds. Such proposals are under consideration in Congress and the Executive Branch. Without public understanding and assistance, however, action is unlikely. Claims that action is too difficult or that funds should be spent elsewhere will likely prevail. Likewise for the international climate change treaty known as the Kyoto Protocol (after the city in which it was written). Under the treaty, nations would commit to mandatory reductions of greenhouse gas emissions. But in the absence of strong public support, efforts to ratify and implement the treaty have stalled.

With your help, we can turn this situation around. By working with community groups, sending letters to your local newspapers, and communicating with public officials, you can help get the message out about how important it is to protect coral reefs and other imperiled habitats, both here at home and around the world.

To learn more about how climate change will affect the world's wildlife and what you can do to help address the problem, contact Patty Glick, NWF's Climate Change & Wildlife Program Coordinator, at (202) 797-6898, or glick@nwf.org. You can also check out NWF's Website at www.nwf.org/international/climate.

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