No. 05-1120

IN THE

Supreme Court of the United States

COMMONWEALTH OF MASSACHUSETTS, *et al.*,
Petitioners,

v.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, *et al.*,
Respondents.

On Petition for Writ of Certiorari to the United States Court of Appeals for the District of Columbia

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BRIEF OF *AMICI CURIAE* OCEAN AND COASTAL CONSERVATION INTERESTS IN SUPPORT OF PETITIONERS

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WILSON-EPES PRINTING CO., INC. – (202) 789-0096 – WASHINGTON, D. C. 20001

TABLE OF CONTENTS

TABLE OF CONTENTS—Continued

TABLE OF AUTHORITIES

TABLE OF AUTHORITIES—Continued

TABLE OF AUTHORITIES—Continued

TABLE OF AUTHORITIES—Continued

TABLE OF AUTHORITIES—Continued

INTEREST OF *AMICI CURIAE* [1]

Amici are organizations and individuals[2] committed to conservation of ocean and coastal ecosystems that provide a wide variety of goods and services of tremendous value to human society including food, commodities, recreation, clean air, and a dazzling array of marine life that enriches the quality of life for all Americans. *Amici* represent a diverse set of interests and expertise in marine conservation. Some organizations have been involved in comprehensive marine conservation and public education efforts for decades. Some are scientists and explorers who have devoted their careers to studying the oceans and improving our understanding of their value and vulnerability. Others are organizations dedicated to protecting marine life and rescuing endangered species. Collectively, these organizations speak for millions of Americans who share a common concern about the impacts of human-induced climate change on these marine ecosystems, and a strong desire to do something about it before it is too late.

SUMMARY OF ARGUMENT

Climate change is real. For evidence of its impact, one need only look to the oceans and coasts of the United States. Ocean temperatures are increasing. Ocean chemistry is changing and becoming more acidic. The polar caps are melting and sea levels are rising. Coastlines are eroding and estuaries are changing. Hurricanes are becoming more powerful and destructive. Coral reefs are dying and the marine foodweb is unraveling. Marine life is under increasing stress as life zones diminish. Human communities closest to the

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[1] All parties have consented to the filing of this brief. Pursuant to this Court's Rule 37.6, *Amici* state that no counsel for any party in this case authored this brief in whole or in part, and no person other than *Amici* and their counsel has made a monetary contribution to the preparation and submission of this brief.

[2] A description of the Amici is included in the Appendix.

oceans and coasts are bearing the brunt of the profound changes underway in the marine environment.

There is a strong and growing scientific consensus that all of these effects are closely linked to the emission of so-called greenhouse gases, including the four compounds at issue here—carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons—that Petitioners seek to have regulated under section 202 of Clean Air Act. EPA declines to act, claiming that it lacks authority to regulate greenhouse gases, and that even if it had authority, it would not use it, for policy reasons. As Petitioners have ably demonstrated in their merits brief, neither contention is tenable. Rather than belabor the legal arguments, *Amici* will briefly review the statutory provisions that plainly authorize EPA to regulate greenhouse gases, and then turn to the scientific evidence that would support a finding that the four pollutants at issue "may reasonably be anticipated to endanger human health or welfare." Indeed, climate change presents a more profound threat to human health and welfare than anything else regulated under the Clean Air Act.

ARGUMENT

I. THE PLAIN LANGUAGE OF SECTION 202 OF THE CLEAN AIR ACT NOT ONLY AUTHORIZES EPA TO REGULATE AIR POLLUTANTS THAT CONTRIBUTE TO CLIMATE CHANGE, BUT UPON THE APPROPRIATE "ENDANGERMENT" FINDING, REQUIRES THAT IT DO SO.

Section 202 of the Clean Air Act provides:

> The Administrator shall by regulation prescribe . . . standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare.

42 U.S.C. § 7521(a)(1).

In section 302(g) the Act defines "air pollutant[s]" as "any air pollution agent or combination of such agents, *including any physical* [*or*] *chemical . . . substance or matter* which is emitted into or otherwise enters the ambient air . . . ." 42 U.S.C. § 7602(g) (emphasis added). In section 302(h) the Act defines "welfare" to include "effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and *climate*, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants." 42 U.S.C. § 7602(h) (emphasis added).

Under section 202, a two-part process is employed for regulating potentially dangerous pollutants. The Administrator makes a threshold decision regarding whether a particular pollutant from new vehicles "cause[s], or contribute[s] to, air pollution which may reasonably be anticipated to endanger public health or welfare." 42 U.S.C. § 7521. If, in the Administrator's "judgment," an air pollutant causes or contributes to pollution that may be reasonably anticipated to endanger public health or welfare, that pollutant must be regulated pursuant to the provisions described in the remainder of section 202. *Id.* The Administrator is to take a broad, proactive approach to this determination. Before the 1977 Amendments to the Clean Air Act, section 202(a)(1) required the Administrator to regulate air pollution from motor vehicles which "endanger[s] the public health or welfare." H.R. Rep. No. 91-1146 (June 3, 1970), *reprinted in* 1970 U.S.C.C.A.N. 5356, 5359. In 1976, the D.C. Circuit interpreted the "endangers" language as permitting "regulatory action to prevent harm, even if the regulator is less than certain that harm is otherwise inevitable." *Ethyl Corp. v. Envtl. Prot. Agency*, 541 F.2d 1, 25 (D.C. Cir. 1976) (*en banc*) ("*Ethyl Corp.*"). As the D.C Circuit explained:

> A statute allowing for regulation in the face of danger is, necessarily, a precautionary statute. Regulatory action

> may be taken before the threatened harm occurs; indeed, the very existence of such precautionary legislation would seem to demand that regulatory action precede, and, optimally, prevent, the perceived threat. As should be apparent, the 'will endanger' language of Section 211(c)(1)(A) makes it such a precautionary statute.

541 F.2d at 13.

In 1977, Congress amended section 202(a)(1) and the other standard-setting provisions in the Clean Air Act to require regulation where endangerment "may reasonably be anticipated." H.R. Conf. Rep. 95-564 (Aug. 3, 1977), *reprinted in* 1977 U.S.C.C.A.N. 1502, 1564. This change reflects Congress's endorsement of the "precautionary approach" described in *Ethyl Corp.*, and indicates its intent that EPA be diligent in identifying and regulating pollutants that may reasonably be anticipated to endanger public health and welfare. This requires the Administrator to consider the best available scientific information, and not wait for conclusive proof, by which time it may be too late to avoid the harm that the Act was designed to prevent.

A. EPA Has Authority to Regulate the Greenhouse Gases at Issue.

Scientists refer to the four compounds at issue—carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and hydrofluorocarbons—as greenhouse gases. EPA argues that it lacks authority to regulate greenhouse gases, claiming that such substances are not "air pollutants" within the meaning of the Clean Air Act. *See* 68 Fed. Reg. 52,922, 52,928 (Sep. 8, 2003). EPA's argument defies the plain language of the statute. Section 202 clearly establishes EPA's authority to regulate pollutants that affect the climate. *See Chevron U.S.A., Inc. v. Natural Res. Def. Council, Inc.*, 467 U.S. 837, 843 n.9 (1984) ("If a court, employing traditional tools of statutory construction, ascertains that Congress had an inten-

tion on the precise question at issue, that intention is the law and must be given effect.")

In fact, Congress left EPA little discretion in determining what qualifies as "air pollutants." Section 302(g) defines "air pollutants" to "includ[e] *any* physical [or] chemical . . . substance or matter which is emitted into or otherwise enters the ambient air." 42 U.S.C. § 7602(g) (emphasis added). Carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons—as physical and chemical substances that are emitted into the air – plainly fall within this definition and are thus within the Administrator's regulatory authority.

In denying the petition, however, EPA claims that these four substances are "not air pollutants," and that it must be cautious about "using broadly worded statutory authority to regulate in areas raising unusually significant economic and political issues when Congress has specifically addressed those areas in other statutes." 68 Fed. Reg. at 52,925 (*citing FDA v. Brown & Williamson Tobacco Corp.*, 529 U.S. 120 (2000)). EPA explains that the only provisions of the Clean Air Act that specifically mention carbon dioxide or global warming are non-regulatory. Further, EPA points to Congress's decision to regulate separately stratospheric ozone depletion as evidence that when Congress intends to address climate change, it will do so in separate legislation.

EPA's arguments simply do not overcome the plain language of the Act. Regardless of whether Congress was contemplating pollutants associated with climate change when it enacted or amended the Clean Air Act, the definition of "pollutant" enables EPA to reach new pollution, as well as old. *See Ethyl Corp.*, 541 F.2d at 13*; see also*, *PGA Tour, Inc. v. Martin*, 532 U.S. 661, 689 (2001) (explaining that statutes can be applied to situations not expressly anticipated by Congress). The Administrator is not entitled to turn a blind eye to advancements in scientific knowledge that reveal new dangers from substances once considered benign or even

beneficial. For example, nitrogen and phosphorous are nutrients necessary for plants and animals to grow and flourish. But excessive concentrations of these nutrients cause serious environmental problems and threats to public health. *See* National Research Council, Clean Coastal Waters: Understanding and Reducing the Effects of Nutrient Pollution. National Academy Press, Washington, D.C., 15 (2000) (Excess nutrients linked to red tides, fish kills, marine mammal deaths, outbreaks of shellfish poisonings, loss of seagrass habitats, coral reef destruction, and the Gulf of Mexico's "dead zone.").

B. EPA May Not Decline Rulemaking For Reasons Not Enumerated in Section 202.

Alternatively, EPA argues that even if it has authority to regulate greenhouse gases it is not inclined to do so for various reasons including, *inter alia*: the multiple sources of pollutants that contribute to climate change; the effect of unilateral regulation of car emissions on international efforts to reduce emissions; and the Administration's efforts to address climate change through other programs. *See* 68 Fed. Reg. at 52,931-33. As Petitioners have pointed out, however, several of these considerations fall well outside the factors which Congress authorized EPA to consider in implementing its section 202 authority. *See* Petition for Certiorari, 14-16. Section 202(a)(1) assigns the Administrator the responsibility to determine whether a pollutant may reasonably be anticipated to constitute an endangerment, but not broad authority to decline to make an endangerment finding on the basis of a wide range of policy considerations. As Judge Tatel explains in his dissenting opinion:

> EPA has transformed the limited discretion given to the Administrator under section 202—the discretion to determine whether or not an air pollutant causes or contributes to pollution which may reasonably be anticipated to endanger public health or welfare—into the

> discretion to withhold regulation because it thinks such regulation bad policy. But Congress did not give EPA this broader authority, and the agency may not usurp it.

Massachusetts v. Envtl. Prot. Agency, 415 F.3d 50, 74 (D.C. Cir. 2005).

The only decision the Administrator is authorized to make pursuant to section 202(a)(1) is the decision whether a pollutant causes or contributes to air pollution which may reasonably be anticipated to endanger public health or welfare. The Administrator does not have the discretion to ignore the standard set forth in section 202 in declining to regulate. Here, EPA acted outside of its statutory authority in denying the petition.

II. THE WEIGHT OF SCIENTIFIC EVIDENCE SUPPORTS A FINDING THAT GREENHOUSE GASES "MAY REASONABLY BE ANTICIPATED TO ENDANGER PUBLIC HEALTH OR WELFARE."

One of the reasons EPA cites for not regulating greenhouse gas emissions under section 202 is "scientific uncertainty." 68 Fed. Reg. at 52,931-33. However, as pointed out by the distinguished group of climate scientists who filed an *amicus curiae* brief in support of granting the Petition for Certiorari and who will be submitting a brief on the merits, both EPA and the panel majority below misrepresent the key findings of the National Academy of Sciences and National Research Council in the 2001 report to Congress, *Climate Change Science*: *An Analysis of Some Key Questions*. *See* Brief *Amicus Curiae* of Climate Scientists in Support of Petitioners, 17-22.

In fact, contrary to EPA's view, there is a strong scientific consensus that increasing levels of greenhouse gases, particularly carbon dioxide, are already having a dramatic impact on ocean systems and all life, including humanity, that depend

upon them. To be sure, there is still considerable uncertainty regarding the magnitude and timing of the changes that are likely to occur. But these very uncertainties carry significant risks of potentially irreversible and catastrophic consequences that argue for prudent action now.

A. The Continued Health and Vitality of Oceans and Coasts is Crucial to Public Health and Welfare.

In 2003, it was estimated that 153 million Americans, or 53% of the United States population, lived in U.S. coastal counties. Kristen M. Crossett et al., *Population Trends Along the Coastal United States: 1980-2008*, 1 (Nat'l Oceanic and Atmospheric Administration, September 2004). *See also*, *Massachusetts v. EPA*, 415 F.3d at 79. The estimated socio-economic value of global ocean and coastal ecosystems is $21 trillion per year through food production, recreation, nutrient recycling, climate regulation, and the oceans' influence over the chemical composition of the atmosphere. R. Costanza et al., *The Value of the World's Ecosystem Services and Natural Capital*, 387 Nature 253 (1997). In the United States, coastal watershed counties contribute over $4.5 trillion per year, half of the nation's gross domestic product, involving about 60 million jobs—many of which are tied to industries directly dependent on healthy coastal and ocean ecosystems and living resources, such as recreation, tourism, and fisheries. U.S. Commission on Ocean Policy, *An Ocean Blueprint for the 21st Century Final Report*, 32-33 (2004). The United States has an extraordinary interest in preserving and protecting the population and industries of the coastal areas.

Coastal fisheries and coastal dependant industries in the United States are large economic contributors. The total value of U.S. commercial fisheries was over $3 billion in 2001. J. Kildow and C. Colgan, *California's Ocean Economy Report to the Resources Agency, State of California*, 35 (July 2005). California beaches alone generate $14 billion in direct

revenues, contribute $73 billion to the national economy, generate $2.6 billion in direct federal taxes, generate $14 billion in indirect taxes, and provide over 883,000 jobs. Philip King, *The Fiscal Impact of Beaches in California*, 3. Public Research Institute, San Francisco State University (September 1999). On average, a 12-inch rise in sea level would inundate 100 feet of dry beach, greatly reducing the area and recreational amenities of many beaches. Increased storminess combined with the direct inundation from sea level would reduce many of the southern California recreational beaches to narrow, hazardous strips of sand with ocean waves on the seaward side and urban development on the inland side. Shore protection would escalate while beach recreation, tourism revenues, taxes and jobs would plummet.

B. Human Activities Are Increasing Atmospheric Concentrations of Carbon Dioxide, Thereby Contributing to Changes in Climate and the Marine Environment.

Most of this discussion focuses on the effects of higher carbon dioxide levels on the ocean environment. Carbon dioxide is the primary contributor among a suite of atmospheric gases that contribute to climate change. Present-day levels of about 370-380 parts per million by volume (ppmv) are unprecedented over the past 420,000 years. Based on historic data (derived from Greenland and Antarctic ice cores,) concentrations of carbon dioxide did not rise much above 280 ppmv prior to the industrial revolution. Today, carbon dioxide levels are increasing at a rate of 1.5 ppmv per year, with the primary sources being fossil fuel burning and tropical deforestation. Depending on the level of future emissions, concentrations could reach 800-900 ppmv by the year 2100. *See* J.T. Houghton et al. (eds.), Climate Change 2001: The Scientific Basis, Cambridge University Press, Cambridge, U.K. (2001) ("Houghton et al."); National Research Council, *Climate Change Science: An Analysis of*

Some Key Questions, National Academy Press, Washington, D.C., 3 (2001) ("Climate Change Science"); J.R. Petit et al., *Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica*, 399 Nature 429-436, 433 (1999).

1. *Increased carbon dioxide levels are affecting atmospheric and ocean temperatures.*

The world's climate is warming; it is going to get much warmer; and humans are significantly responsible. There is scientific consensus that the observed global warming over the past century—of 0.4 to 0.8ºC (0.7 to 1.5ºF)—is due to increases in greenhouse gas concentrations and that this warming has been particularly strong over the past 20 years. In confirming this finding by the Intergovernmental Panel on Climate Change (IPCC), the United States National Research Council also affirmed the scientific validity of the IPCC's prediction that warming would increase by the end of the century by 1.4 to 5.8ºC (2.5 to 10.4ºF).[3] This warming will be greater over higher latitudes. Houghton et al. at 26; *Climate Change Science* at 3.

2. *Increased carbon dioxide levels are creating a fundamental and detrimental shift in ocean chemistry.*

Through the absorption of a substantial portion of the carbon dioxide emitted by human activities, the oceans are becoming more acidic, with dramatic consequences for organisms from corals to the planktonic foundation of marine food webs.

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[3] The National Research Council's review of the state of climate science at the White House's request reaffirmed the scientific soundness of the IPCC's projections of greenhouse gas loadings in the atmosphere, global warming, ocean warming, and sea-level rise. *See Climate Change Science* at 22-23.

On timescales of several thousands of years, the oceans will ultimately absorb about 90 percent of the carbon dioxide in the atmosphere. However, because of slow mixing time, the ocean has only taken up about 30 percent of the carbon dioxide emitted in the past twenty years or so. From 1800 to 1994, the ocean has absorbed about 48 percent of fossil-fuel and cement-manufacturing emissions. C.L. Sabine et al., *The oceanic sink for anthropogenic CO2*, 305 Science 367-371 (2004).

While this "ocean sponge" effect has certainly forestalled more pronounced climate change above the surface, it is substantially lowering pH and saturation states of the carbonate minerals, making it increasingly difficult for the many major groups of marine organisms that use these minerals to build skeletons and shells. Assuming carbon dioxide emissions continue at the current pace, surface water pH levels will decrease by 0.4 pH units relative to the preindustrial level by 2100, lower than it has been in millions of years. J.A. Kleypas, R.A. Feely, V.J. Fabry, C. Langdon, C.L. Sabine and L.L. Robbins, *Impacts of Ocean Acidification on Coral Reefs and other Marine Calcifiers: A Guide for Future Research*, Report of a workshop held 18-20 April 2005 in St. Petersburg, Fla., sponsored by NSF, NOAA, and the U.S. Geological Survey, 69 (2006) ("Kleypas et al."); *see also*, K. Caldeira and M.E. Wickett, *Anthropologic carbon and ocean pH*, 425 Nature 365 (2003).

Calcifying organisms are sensitive to changes in ocean chemistry; even small changes will have large impacts, and it is clear that their ability to grow calcium carbonate shells and skeletons will decrease with increasing acidification. Extrapolations of laboratory experiments indicate that calcification rates will decrease up to 60 percent during the 21st century. This reduction will affect individual corals and the ability of reefs to maintain a positive balance between reef building and reef erosion, which is the process by which corals' calcium

carbonate skeletons are rubbed, scraped, and chewed away by a combination of physical forces and reef fish. Kleypas et al. at 1, 5.

Basic chemistry dictates that as carbon dioxide levels in seawater increase, not only will calcification decrease, but, at some point, calcium carbonate skeletons will also dissolve. Although there are many questions about the particulars of organism survival and ecosystem effects, it is clear that at some threshold level of carbon dioxide, reef dissolution will exceed calcification—the reef equivalent of osteoporosis. Although that may occur at different times and in different ways from reef to reef, it will be yet another substantial blow to the prospects for reef survival. *Id.* at 26-27.

There are also a variety of planktonic calcifying organisms, many of which form an important foundation of marine food webs. As with corals, there is clear evidence that elevated carbon dioxide levels reduce calcification in these species. In fact, data suggest that in some plankton species, this is not a linear relationship as it is among corals, but rather that there may be a threshold value below which there will be sudden and large decreases in calcification rates. *Id.* at 30. And, as with corals, it is not yet known whether or how planktonic calcifiers can adapt to reduced calcification rates. *Id.* at 31. However, since calcification does confer advantages to these species, decreased calcification is likely to compromise their fitness and thus impact marine food webs, which would substantially alter the biodiversity and productivity of the ocean. *Id.* at 69.

C. Changes to the Ocean Environment Will Have Major Adverse Effects on Human Safety, the Economy, and the Natural Environment.

Although a relatively slow process compared to the warming of the atmosphere, the warming of oceans is occurring by virtue of their interaction with the air above them. Since the

1950s, the top 10,000 feet of the oceans have warmed by an average of 0.05ºC (0.09ºF), *Climate Change Science* at 16. Temperatures at the sea surface, where hurricanes are spawned and corals live, have warmed 0.4 to 0.8ºC since the late 1800s. Houghton et al. at 35. The implications of this warming are numerous and serious from a public health and welfare perspective. Among these implications are:

1. *Sea-level rise will have negative effects on the health and welfare of U.S. populations in coastal areas.*

The changing climate causes sea level to rise in two basic ways: warmer ocean waters take up greater volume and melting glaciers and ice fields increase water supply to the oceans.

Estimates of sea-level rise over the past century range from 0.10 to 0.20 meters, with average rates of 1.0 to 2.0 mm per year. Scientists consider it very likely that global warming during this period contributed substantially to these increases. There is a great deal of historical support for this conclusion; the correlation among past changes in atmospheric carbon dioxide, global warming, and changes in global sea level is well represented in the geologic record. Houghton et al. at 641, 643; *see also,* R.B. Alley, P.U. Clark, P. Huybrechts and I. Joughin, *Ice-sheet and sea-level changes*, 310 Science 456-460 (2005).

Based on climate change projections, scientists consider it highly likely that sea levels will increase between 0.09 and 0.88 meters for 1990 to 2100, with a central value of 0.48 meters. This represents an increase of 2.2 to 4.4 times the 20th century rate. Houghton et al. at 642.

Although this steady increase is documented, there is concern by scientists that the ice caps in Greenland and Antarctica could melt, causing even greater sea level rise. Recent reports point to startling changes at the margins of the Greenland and Antarctic ice sheets which indicate that projec-

tions of sea-level rise need to be revised upward. The collapse of the Larsen B Ice Shelf in 2002 was followed by an acceleration of its major tributary glaciers by two- to eight-fold, contributing about 0.07 mm per year to sea-level rise.[4] Alley et al. at 458. This process is also playing out along the Amundsen Coast of the Antarctic Peninsula. *Id.*

Similar warming-caused losses of glacier-restricting ice shelves along the coast of Greenland have led to increased contributions to sea-level rise of up to 0.09 mm per year. I. Joughin, W. Abdalati and M. Fahnestock, *Large fluctuations in speed on Greenland's Jakobshavn Isbrae glacier*, 432 Nature 608-610 (2004). For some time, the West Antarctic ice sheet (WAIS) has been the subject of great scientific focus because it contains enough ice to raise sea levels by 6 meters and is relatively unstable. Houghton et al. at 642.

2. *Warming and acidification of the oceans pose grave threats to coral reefs and will adversely affect all marine life.*

Immersed in warming oceans, sensitive marine organisms must adapt, alter their geographic distribution (i.e., shift poleward), or face extinction. There is scientific evidence for all of these responses. Degradation of marine life will negatively affect U.S. population by affecting food suppliers, coastal fisheries, marine biological diversity, and the economy.

Coral reefs are among the most sensitive ecosystems to climate change, and the most conservative estimates suggest

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[4] It is the melting of land-based glaciers and ice caps that increases sea levels, just as pouring water in a bucket causes the level to rise. On the other hand, ice shelves, which float on the water surface, do not add directly to sea-level rise as they melt (just as ice melting in a drink does not cause the level of liquid to rise). But, ice shelves do block the flow of glaciers like dams, and when the shelves break apart, land-based ice flows more rapidly to the sea, increasing the rate of sea-level rise.

that half of all reefs will be destroyed by 2030-2050. C. Wilkinson ed. *Status of Coral Reefs of the World*: *2004*, 25. Australian Institute of Marine Science (2004) ("Wilkinson"). Much more than their beauty and recreational value will be lost. Coral reefs buffer shorelines from storms and erosion and provide home, food, and nursery for tens of thousands of marine species. They provide an estimated $375 billion per year in goods and services worldwide, with approximately 500 million people dependent upon them for food, materials, or income. The U.S. has a significant stake in the fate of reef systems worldwide. Approximately half of all U.S.-managed commercial fish species depend on coral reefs for at least a portion of their life cycle. U.S. Commission on Ocean Policy at 321-22.

Extinction due to increases in sea-surface temperatures is a real prospect for shallow-water, tropical corals. It is clear that many corals are operating within very close margins of their thermal tolerance, with bleaching occurring for many species at about 1ºC above mean summer maximum temperatures, and causing widespread concern as this threshold will be chronically exceeded as temperatures rise over the next 50 years. T.P. Hughes et al., *Climate change, human impacts, and the resilience of coral reefs*, 301 Science 929-933, 930 (2003). There is evidence that at least some corals and their algal symbionts (called zooxanthellae, which provide nourishment and lend color to corals) may be able to adapt to increasing temperatures, but it is not clear that they will be able to adapt quickly enough to keep pace with the accelerating rate of environmental change. *Id.*

Evidence from the field is not encouraging. About 20 percent of the world's coral reefs have been effectively destroyed as a result of increasing sea-surface temperatures and show no immediate prospects for recovery. Another 24 percent of them are under imminent risk of collapse, and a further 26 percent are under a longer-term threat of collapse.

Wilkinson at 7. Caribbean reefs are in catastrophic decline, with two of the major reef-building coral species in this area—staghorn and elkhorn—recently listed as endangered under the U.S. Endangered Species Act. *Id.* at 14; 71 Fed. Reg. 26,852 (May 9, 2006) (to be codified at 50 C.F.R. pt. 223).

A major global bleaching event in 1998 destroyed 16 percent of the world's coral reefs, with most of the damage in the Indian Ocean (50 percent destroyed) and the western Pacific. Unfortunately, what was then a once-in-a-thousand-years event will become a regular occurrence within 50 years based on projections of tropical sea-surface temperature increases in the range of 1 to 3ºC by 2100. Wilkinson at 21.

Ocean warming is having an impact on the distributions of other important species. For example, warm-water populations of copepods, small marine organisms that form a vital link in the food web as a food source for the larvae of many commercial and non-commercial marine fish, have moved 1,000 km northward in the northeast Atlantic over the past 40 years, accompanied by retraction in the range of their cold-water cousins. G.C. Hays, A.J. Richardson and C. Robinson, *Climate change and marine plankton*, 20 Trends in Ecology and Evolution 337-344, 339 (2005) ("Hays et al."). Similar shifts have been shown among marine snails, corals and fish. C.D.G. Harley et al., *The impacts of climate change in coastal marine systems*, 9 Ecology Letters 228-241, 234 (2006) ("Harley et al."). Some of these adjustments can be abrupt, affecting the survival of not only the adjusting species, but also many others, with huge implications for commercial fisheries and the basic functioning of marine ecosystems. Hays et al. at 340; G.A. McFarlane, J.R. King and R.J. Beamish, *Have there been recent changes in climate? Ask the fish*, 47 Progress in Oceanography 147–69 (2000).

If species that otherwise depend on one another, for instance as predator and prey, respond differently to ocean

warming, the consequences can be significant. There is evidence of warming-induced mismatches in the timing of the spawning of certain zooplankton, the arrival of fish larvae, and blooms of the phytoplankton they eat, thus jeopardizing the survival of fish species and potentially affecting commercial fisheries. Harley et al. at 232; Hays et al. at 342.

Alteration of aquatic habitats and species distributions by warming temperatures also exacerbates problems with invasive species, making native populations more susceptible to invasion. U.S. Commission on Ocean Policy at 253.

3. *Hurricane intensity will likely increase because of warmer oceans.*

There is growing evidence that the theoretical link between warming seas and hurricane intensity exists in fact, based on broad confluence of theory, modeling and observations. R.A. Anthes et al., *Hurricanes and global warming—potential linkages and consequences*, 87 Bulletin of the American Meteorological Society 623-628 (2006) ("Anthes et al."); *see also* T.R. Knutson and R.E. Tuleya, *Impact of CO2-induced warming on simulated hurricane intensity and precipitation: Sensitivity to the choice of climate model and convection parameterization*, 17 Journal of Climate 3477-3495 (2004); K. Trenberth, *Uncertainty in hurricanes and global warming*, 308 Science 1753-1754 (2005). Nonetheless, this assertion remains controversial.[5] Tropical sea-surface temperatures have risen by about 0.6ºC since measurements began and about 0.5ºC of that increase has occurred since 1970. Anthes et al. at 624. Record sea-surface temperatures (0.9ºC above

[5] The debate involves questions about the possible underestimation of the intensity of historic tropical cyclones, thus making more recent storms appear stronger by comparison. In addition, accurate assessments of tropical cyclone intensity, based on satellite data, are relatively recent. Thus, there is a need for additional data to allow formal statistical confirmation of conclusions based on this evidence.

the norm) in the area critical for hurricanes contributed to the most active North Atlantic hurricane season on record in 2005; about half of that temperature anomaly can be attributed to global warming. K.E. Trenberth and D.J. Shea, *Atlantic hurricanes and natural variability in 2005*, 33 Geophysical Research Letters L12704, doi:10.1029/2006GL 026894 (2006).

A careful review of global data confirms a trend toward more frequent intense (category 4 and 5) storms over the past 30 years, a trend directly linked to increases in sea-surface temperatures. P.J. Webster, G.J. Holland, J.A. Curry and H.-R. Chang, *Changes in tropical cyclone number, duration, and intensity in a warming environment*, 309 Science 1844-1846 (2005); C.D. Hoyos, P.A. Agudelo, P.J. Webster and J.A. Curry, *Deconvolution of the factors contributing to the increase in global hurricane intensity*, 312 Science 94-97 (2006); K. Emanuel, *Increasing destructiveness of tropical cyclones over the past 30 years*, 436 Nature 686-688 (2005) ("Emanuel").

Even if tropical storms do not change markedly in intensity, rising sea levels, beach and wetland erosion, and storm surges will ensure increased damage along increasingly developed shorelines. *Climate Change Science* at 4; Anthes et al. at 624. Hurricanes are already the costliest natural events in the United States, accounting for a significant fraction of damage, injury and loss of life from natural hazards. Emanuel at 686.

4. *Increased storm damage endangers U.S. coastal communities.*

Large swaths of low-lying coastal lands around the United States are extremely vulnerable to any increase in sea level. As Hurricane Katrina demonstrated, such areas are already vulnerable to erosion, flooding, storm surges, and tsunamis; and poor development planning has placed trillions of dollars

worth of buildings and infrastructure directly in the path of these threats. Further, higher sea levels interact with tides and storms to create more destructive impacts, as extreme high water levels occur with more frequency. Dan Cayan et al., *Projecting Future Sea Level Rise: A Report for California Climate Change Center*, 18 (March 2006) ("Cayan et al."). Approximately 58,000 square kilometers of land along the Atlantic and Gulf of Mexico coasts of the United States lie below 1.5 meters above sea level. Louisiana, Florida, Texas, and North Carolina account for more than 80 percent of these low-lying areas. In fact, North Carolina alone has as much land within one meter of sea level as the Netherlands. J.G. Titus and C. Richman, *Maps of lands vulnerable to sea level rise: Modeled elevations along the US Atlantic and Gulf Coasts*, 18 Climate Research 205-228 (2001).

In California, a 30 cm (12 inch) rise in sea level would shift the 100-year storm surge-induced flood event to once every 10 years. Cayan et al. at 18. Even a small rise in sea level would be accompanied by large amounts of coastal flooding, inundation and storm damage. Along the San Diego coast, model results demonstrate approximately 10 extreme water level events between 2070 and 2100 if there is no increase in sea level. Over the same time period there would be approximately 330 extreme events with a rise in sea level of 20 cm, 2,300 extreme events with a rise of 40 cm, and almost 19,000 events with a rise of 80 cm. *Id.* at 23-29.

For the 85 coastal counties from Massachusetts to Virginia, approximately one thousand square miles of land area lies below 3 feet, which includes about 70 square miles of developed land, 3,000 miles of roads, and about 388,000 people. S.-Y. Wu, R. Najjar and J. Siewert, *Impact of Sea-Level Rise on the Mid- and Upper-Atlantic Coast* (Consortium for Atlantic Regional Assessment, 2005).

5. *Erosion will increase in coastal areas.*

Each year, erosion along U.S. shorelines will claim about 1,500 homes and the property they occupy at a cost of about $530 million annually. The H. John Heinz III Center for Science, Economics and the Environment, *Evaluation of Erosion Hazards*, Report Brief, 2 (2000). According to the Federal Emergency Management Agency, by 2060, coastal erosion will have threatened nearly 87,000 homes in U.S. coastal areas. G.B. Griggs, *Coastal Cliff Erosion in San Diego County* (2002) *at* http://repositories.cdlib.org/cgi/viewcontent.cgi?article=1091&context=csgc (last visited August 29, 2006).

The nature and extent of human development has severely undermined the ability of natural coastal features, such as wetlands and mangrove forests, to survive increasing seas. Under normal circumstances, they can accrete sediment to keep pace with, and retreat in the face of, rising sea levels. However, dams and levees impede the flow and deposition of sediments, a situation played out with devastating consequences in the Mississippi delta in Louisiana. The delta has lost more than 1,000 square miles since 1950, and continues to lose 25-35 square miles per year through the combination of sea-level rise, land subsidence, and erosion. At this pace, more that 630,000 acres of Louisiana wetlands will disappear by 2050. Pew Oceans Commission, *America's Living Oceans: Charting a Course for Sea Change*, 54 (June 2003).

CONCLUSION

For the foregoing reasons, *Amici* respectfully urge the Court to reverse the Court of Appeals and direct that the case be remanded to EPA with instructions for making a proper determination under section 202 of the Clean Air Act.

Respectfully submitted,

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* Counsel wishes to acknowledge Christophe A. G. Tulou of Christophe Tulou Associates for his substantial contributions to this brief.

APPENDIX

LIST OF *AMICI CURIAE*

American Littoral Society (ALS). Currently comprised of over 6,000 professional and amateur naturalists, ALS seeks to encourage a better scientific and public understanding of the marine environment and provide a unified voice advocating protection of the delicate fabric of life along the shore.

Cetacean Society International (CSI). CSI advocates for laws and treaties that prevent habitat destruction and minimize cetacean killing and captures, while maximizing human activities that neither harm nor harass, but instead enhance public awareness of and concern for cetaceans and the marine environment.

Humane Society of the United States (HSUS). With nearly ten million members and constituents, The HSUS is the nation's largest animal protection organization. The HSUS strives to protect, conserve, and enhance the nation's wildlife and wildlands while also promoting the humane treatment of all animals, including marine life. In particular, The HSUS, together with its international arm, The Humane Society International, has an extensive array of domestic and international programs that focus specifically on concerns facing marine environment and encourages its members to weigh in on these issues by contacting leaders and decision-makers. Additionally, HSUS submits comments on a wide range of issues pertaining to marine mammals and their environment and litigates complex cases to preserve marine life.

International Wildlife Coalition Inc. (IWC). Founded in 1984, the Coalition is dedicated to public education, research, rescue, rehabilitation, litigation, legislation and international treaty negotiations concerning global wildlife and natural habitat protection issues.

Jean-Michel Cousteau. The president of Ocean Futures, Jean-Michel Cousteau has been a voice of concern for oceans in countries across the world for decades. He served as a spokesman on water issues at the United Nations World Summit on Sustainable Development in Johannesburg, at the 3rd World Water Forum in Kyoto, and at the Dialogues on Water for Life and Security in Barcelona.

Marine Conservation Biology Institute (MCBI). Our mission is to advance the science of marine conservation biology and secure protection for ocean ecosystems.

Nantucket Soundkeeper/Alliance to Protect Nantucket Sound (APNS). Our goal is to protect Nantucket Sound in perpetuity through conservation, environmental action, and opposition to inappropriate industrial or commercial development that would threaten or negatively alter the coastal ecosystem.

The Ocean Conservancy. The oldest and largest organization solely dedicated to ocean conservation, we represent 150,000 members on ocean conservation issues. We promote healthy and diverse ocean ecosystems and oppose practices that threaten ocean life and human life.

Ocean Futures Society. Ocean Futures Society, a non-profit marine conservation and education organization, serves as a voice for the ocean by communicating in all media the critical bond between people and the sea and the importance of wise environmental policy.

Oceans Public Trust Initiative (OPTI). OPTI is a project of the Earth Island Institute's International Marine Mammal Project and our mission is to ensure that the public trust interest in ocean and coastal areas is fully protected by state and federal governments.

Provincetown Center for Coastal Studies (PCCS). PCCS conducts scientific research with emphasis on marine

mammals of the western North Atlantic and on the coastal and marine habitats and resources of the Gulf of Maine. Our mission includes promoting stewardship of coastal and marine ecosystems and working on issues of habitat protection, ecosystem management, marine mammal and marine wildlife conservation.

SeaWeb. SeaWeb is a communications-based nonprofit organization dedicated to advancing ocean conservation.

Whale and Dolphin Conservation Society (North America) (WDCS (NA)). WDCS (NA) is a MA incorporated not-for-profit and is part of the WDCS group. Established in 1987, WDCS is the global voice for the protection of whales, dolphins and their environment.