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Delivered by Hand and Electronic Mail:

John R. Griffin
Secretary
Maryland Department of Natural Resources
Office of the Secretary Executive Direction
Tawes State Office Building C4
580 Taylor Avenue
Annapolis, MD 21401-2397

RE: PETITION FOR RULEMAKING TO RESTRICT DEFORESTATION IN THE STATE OF MARYLAND TO MITIGATE CLIMATE CHANGE

Dear Secretary Griffin:

This petition is submitted on behalf of Kids vs. Global Warming and other children residing in the State of Maryland ("Petitioners"), pursuant to the Maryland Administrative Procedure Act, see Md. Code Ann., State Gov't § 10-23, requesting that the Maryland Department of Natural Resources ("Department") immediately take all necessary action to cease logging in Maryland owned forests to mitigate greenhouse gas emissions and enhance carbon sequestration.

I. INTRODUCTION

As demonstrated more fully below, the current regulatory regime governing forests in Maryland fails to fulfill the State's own recognition that "[f]orests and trees are key indicators of climate change and can mitigate greenhouse gas emissions by carbon sequestration," id., Nat. Res. § 5-102(a)(3). Further, in allowing the regular destruction and logging of State owned forests, and privately-owned forests over which the Department exercises permitting jurisdiction, without any consideration of the climate change impacts of such activities, the Department has failed to exercise its public trust responsibility over "the air, land, water, living and historic resources" that it has "an obligation to protect … for the use and enjoyment of this and all future generations." Id. § 1-302(c).

The Department has the responsibility to "promote, administer, and manage" the State's forests, id. § 5-201(a); and the authority to promulgate regulations for the protection of Maryland's forests. See § 5-209(a). Further, under the public trust doctrine, a binding legal principle recognized under State law, see, e.g., Bausch & Lomb Inc. v. Utica Mut. Ins. Co., 625 A.2d 1021, 1035 (Md. 1993), the Department is a "trustee" of natural resources such as the atmosphere, forests, water bodies, and land – resources that constitute trust property that must be managed and protected by the Department as trustee on behalf of its beneficiaries, i.e., the people of Maryland, and especially its youth. Indeed, the public trust principle holds the Department responsible, as perpetual trustee, for the protection and preservation of the atmosphere for the benefit of the present and future generations. Under this doctrine, the Department may not manage the trust resource in a way that substantially impairs the public's ability to enjoy a healthy atmosphere.

For over the past 200 years, the burning of fossil fuels, such as coal and oil, together with massive deforestation have caused a substantial increase in the atmospheric concentrations of heat-trapping gases such as carbon dioxide, methane and nitrogen oxide, which prevent heat from escaping to space, like the glass panels of a greenhouse - and hence are referred to as "green house gases" ("GHGs"). U.S. Global Change Research Program, Global Climate Change Impacts In The United States 13 (2009) ("Global Climate Change Impacts").[1] The extent of these gases in the atmosphere have changed and fluctuated over geologic time but have reached an equilibrium -- Earth's safe climate-zone -- which is necessary to life as we know it. Id. at 12. However, as the concentrations of these gases continue to increase in the atmosphere, the Earth's temperature is climbing above Earth's safe climate-zone. The Earth's average surface temperature has increased by about .67° to .8°C (1.2 to 1.4ºF) in the last 100 years. Envtl. Prot. Agency (EPA), Technical Support Document for Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act 17

[1] Available at http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf

(December 9 2009) at ES-2 ("TS Endangerment Findings");[2] National Aeronautics and Space Administration (NASA), Climate Change: Key Indicators.[3] In fact, the eight warmest years on record (since 1850) have all occurred since 1998. Coupled with the increase in the temperature of the earth, other aspects of the climate are also changing, such as rainfall patterns, snow and ice cover, and sea levels.

A variety of studies conclude that a further increase of average annual temperatures of 2ºC (3.6ºF) above current levels will cause severe, widespread and irreversible impacts, more fully described below. In the absence of governmental actions to mitigate climate change, the future is likely to bring increases of 3 to 11ºF above current levels. If the Department, as the trustee of natural resources for the State of Maryland, including the atmosphere and forest resources, does not take immediate action to protect, preserve and attempt to bring the atmosphere back into balance, our children and our children's children will continue to suffer greater injury and damaging consequences.

The Department must accept and honor this fiduciary responsibility because Maryland is one of the most vulnerable states to climate change and sea level rise in the United States. See James G. Titus and Charlie Richman, Maps of Lands Vulnerable to Sea Level Rise: Modeled Elevations along the U.S. Atlantic and Gulf Coasts 1.[4] In fact, in the last century, Maryland has experienced rising temperatures, increased precipitation, more severe weather events, and a rise in sea level. See Md. Comm'n on Climate Change, Climate Change Impacts on Maryland and the Cost of Inaction, in Climate Change Action Plan 3 (Aug. 27, 2008) ("Md Climate Change Action Plan").[5] Maryland's average annual temperature has increased by about 2°F (1°C) since 1990, average precipitation has increased by 10 % throughout most of Maryland, and the sea level along the Maryland coastline has risen at a rate of 3-4 mm/year (.14 inch/year) over the last century – nearly twice the global average. Id. In this regard, the Maryland Commission on

[2] Available at http://www.epa.gov/climatechange/endangerment.html
[3] Available at http://climate.nasa.gov/keyIndicators.
[4] Available at http://epa.gov/climatechange/effects/downloads/maps.pdf
[5] Available at http://www.mde.state.md.us/programs/Air/ClimateChange/Pages/Air/climatechange/legislation/index.aspx

Climate Change has warned that "[t]hese trends are predicted to continue or worsen if climate change progresses unchecked." Id.

Deforestation and degradation of forests worldwide account for 20-25% of the global anthropogenic GHG emissions. Clearing and degradation of forests exacerbate climate change because forests act as both a source and sink of carbon dioxide, i.e., on the one hand, healthy standing forests store carbon, and on the other, logged or burned forests release additional carbon dioxide into the atmosphere. "In essence, forests and other highly productive ecosystems can become biological scrubbers by removing (sequestering) [carbon dioxide] from the atmosphere." Robert N. Stavins and Kenneth R. Richards, The Cost of U.S. Forest-based Carbon Sequestration 3 (Pew Ctr. on Global Climate Change, Jan. 2005) ("Cost of U.S. Forest-based Carbon Sequestration").[6]

In its most recent survey of forests in Maryland, the United States Forest Service found that "[w]ith increases in urban development and population growth over the last half century, Maryland has lost more than 450,000 acres of forest land," and that "[r]ecent inventories indicate that forest land is still being lost[.]" Lister et al., Maryland's Forest Resources: 2009 3 (U.S. Dep't of Agric., Forest Serv., N. Research Station, 2011).[7] The Department has contributed to, and continues to contribute to, the climate catastrophe by permitting logging and deforestation in Maryland. It has failed to preserve and protect the atmospheric trust from GHG emissions because deforestation increases carbon in the atmosphere and destroys the ability of forests to absorb carbon from the atmosphere.

To help return Earth's energy balance and protect its natural systems, the Department must protect, preserve, and enhance Maryland's forest resources as carbon sinks to reduce the State's fair share of annual carbon dioxide emissions and draw down atmospheric carbon dioxide by about 40 parts per million ("ppm") by the end of this century. To limit average surface heating to no more than 1°C (1.8°F) above pre-industrial temperatures, concentrations of atmospheric carbon dioxide should be no more than 350 ppm (currently carbon dioxide concentrations have already reached 390 ppm and are projected to exceed 400 ppm). Thus, it is

[6] Available at http://www.pewclimate.org/publications/report/cost-us-forest-based-carbon-sequestration

[7] Available at http://nrs.fs.fed.us/pubs/37257

crucial that the Department take expeditious and concrete steps to draw down the carbon dioxide from the atmosphere by both restricting deforestation as much as possible, and also requiring significant reforestation. The public trust doctrine requires the Department to carry out its fiduciary and ongoing affirmative duty to protect and manage the State forests and atmosphere -- the trust resources -- for its present citizens and future generations as beneficiaries of this trust asset. If the Department does not act immediately to reduce carbon dioxide in the atmosphere through forest-based carbon sinks, Petitioners and future generations of children in Maryland will face a planet that may be largely uninhabitable.

II. PETITIONERS

Petitioner Kids vs. Global Warming ("KvGW") is a national youth-led non-profit organization that works with youth from all over the country, including Maryland, to address climate change. KvGW is engaged with youth who are concerned about how climate change is affecting, and will continue to affect, them and their future. KvGW is a project of the Earth Island Institute and is dedicated to educating youth about the science and solutions to climate change and empowering them to take action. KvGW educates through youth-created and delivered, inspirational presentations to schools, conferences and events as well as videos, interactive booths, websites, educational resources and organizing other advocacy efforts. The organization empowers youth by initiating global warming action teams and providing resources and tools so that youth can be trained to give presentations in their own communities, make their schools "green," and initiate advocacy projects. The message of KvGW is: "Kids' voices matter in the fight to end global warming within their lifetimes."

Petitioner Connor Hocking is a resident of Maryland who lives in Annapolis. He is 16 years old and is concerned about the fact that the quality of life for this and future generations is being, and will continue to be seriously affected by climate change. He enjoys hiking and the beauty of Maryland's natural resources and feels strongly that those resources cannot be taken for granted as they continue to be compromised by climate change. He also believes future generations should have the opportunity for these same types of experience. In 2050, when the worst effects of climate change are projected to be seen, Mr. Hocking will be 55 years old. If the Department does not do its part to protect, preserve and restore a healthy atmosphere, Mr.

Hocking and his children will suffer greater injury and damaging consequences due to climate change.

Petitioner Claudia Lewis is a resident of Maryland living in the town of New Windsor. Ms. Lewis has been a science teacher for 40 years. During her teaching tenure, she has attempted to educate her students to be members of a participatory democracy. She also has three children of her own and two grandchildren, on whose behalf she submits this petition. Ms. Lewis is extremely concerned about the degradation of the quality of life for her children, grandchildren and future generations because of the serious climate change crisis that we are now facing. She considers the problem to be a social justice issue, because, as the climate warms and there is more unpredictable weather, the food supply will become compromised, making it more difficult to provide food for the world population; and, as the sea level rises, there will be more migration of people seeking to reestablish themselves in foreign countries. With an advanced degree is in cytogenetics, Ms. Lewis understands the scientific issues related to climate change, including that the Earth has natural cycles that impact the temperature and weather patterns, such as sunspots, El Nino, La Nina, and earth wobble. However, it is also very clear that our fossil fuel economy is rapidly contributing significant GHGs to our atmosphere that exacerbate these natural cycles. She recognizes the need for immediate measures to lower the atmospheric deposition of carbon dioxide, methane, and nitrogen oxides. As a Maryland resident, she is particularly aware of the dangers of excess carbon dioxide on the aquatic life in the Chesapeake Bay -- acidification of the bay will destroy the unique food web that we associate in the bay, and rising sea levels will destroy the wetland nurseries of many bay species. Ms. Lewis's children and grandchildren deserve better than what they have inherited.

III. FACTUAL BACKGROUND

A. We Are Facing a Global Climate Change Crisis Where the Atmosphere is Warming Alarmingly Fast With Serious Consequences For The Survival of Our Planet.

Global heating is significantly and adversely impacting the Earth's climate. Global Climate Change Impacts at 13. Although some degree of global heating is a normal natural phenomenon, the trend of global heating in the past several decades has occurred largely as a result of human activities that release heat-trapping GHGs and intensify Earth's natural greenhouse effect, at an accelerated rate, thereby changing Earth's climate. Id. ("The global warming of the past 50 years is due primarily to human-induced increases in heat-trapping gases."). This abnormal climate change is unequivocally human-induced, id. at 12, is occurring now, and will continue to occur unless drastic measures are taken to curtail it. Id. ("Future climate change and its impacts depend on choices made today.").

Climate change is damaging natural systems, and, if unrestrained, will threaten the planet's habitability for humans as well as countless other species. Id. We have changed the atmosphere and its climate system by engaging in activities that produce or release GHGs into the atmosphere – burning fossil fuels, driving cars, raising livestock on an industrial scale, and cutting down forests. Although much of excess carbon dioxide is absorbed by the oceans and by forests, the increase of GHG concentrations resulting from historic and current human activities coupled with massive deforestation and forest degradation has altered the Earth's ability to maintain the delicate balance of the energy it receives from the sun and radiates back into space. John Abatzoglou et al., A Primer on Global Climate Change and Its Likely Impacts, in Climate Change: What It Means For Us, Our Children, And Our Grandchildren 11, 15-22 (Joseph F. C. DiMento & Pamela Doughman eds., MIT Press 2007). This human-induced global energy imbalance has caused most of the global warming over the last 50 years or so. The current carbon dioxide concentration in our atmosphere is 390 ppm (compared to the pre-industrial concentration of 280 ppm), the highest concentration of carbon in the atmosphere in at least 800,000 years. See National Oceanic and Atmospheric Administration (NOAA), Atmospheric CO2 : Monthly & Annual Mean CO2 Concentrations (ppm), March 1958 – Present, (showing an atmospheric CO2 concentration of 392.40 for March, 2011);[8] see also Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report: Climate Change 2007 37 (2007) ("AR4");[9] Nat'l Sci. and Tech. Council, Scientific Assessment of the Effects of Global Change on the United States 2 (May 2008) ("Scientific Assessment") ("The globally averaged

[8] Available at http://co2now.org/Current-CO2/CO2-Now/Current-Data-for-Atmospheric-CO2.html

[9] Available at http://www.ipcc.ch/publications_and_data/ar4/syr/en/mains1.html#1-1

concentration of carbon dioxide in the atmosphere has increased from about 280 parts per million (ppm) in the 18th century to 383 ppm in 2007.");[10] TS Endangerment Findings at 17.

A variety of studies conclude that a further increase of average annual temperatures of 2ºC (3.6ºF) above current levels would cause severe, widespread, and irreversible impacts, more fully described below. The CNA Corp., Military Advisory Bd., National Security and the Threat of Climate Change 7 (2007).[11] The latest assessment report released by the IPCC on the impacts of climate change, paints a formidable picture of the serious impacts of climate change. Physical and biological systems on all continents and in most oceans are already being affected by climate change, particularly regional temperature increases. See 4AR at 81. Specifically, the IPCC Report documents several impacts of climate change such as increasing catastrophic floods due to earlier break-up of river-ice and heavy rain, id. at 89, increase in droughts due to dry and unusually warm summers, id., shoreline and coastal erosion and wetland losses due to sea-level rise caused due to sea-level rise, enhanced wave heights, and increased intensity of storms, id. at 93-94, changes in the phenology and yield of agricultural crop and livestock, id. at 105, and increased forest degradation due to insect expansion, and increased forest-fire occurrence. Id. at 107 ("both agriculture and forestry show vulnerability to recent extreme heat and drought events"). Climate change is also having a serious impact on human health resulting in increase in mortality due to "heat waves," i.e., "temperature extremes of short duration," id. at 109, and spread of vector-borne, food- and water-borne and pollen- and dust-related diseases. Id. at 108.

Further, according to a 2010 National Academy of Sciences report, climate shifts have already begun to dramatically change the ranges and distribution of many animal and plant species. Nat'l Research Council, America's Climate Choices: Advancing the Science of Climate Change (2010), at 212 ("NAS Report");[12] see also Camille Parmesan, Ecological and Evolutionary Responses to Recent Climate Change, 37 Annual Rev. Ecol. & Evol. Syst. 637-69

[10] Available at http://www.climatescience.gov/Library/scientific-assessment/Scientific-AssessmentFINAL.pdf
[11] Available at http://securityandclimate.cna.org/report/SecurityandClimate_Final.pdf
[12] Available at http://dels.nas.edu/resources/static-assets/materials-based-on-reports/reports-in-brief/Science-Report-Brief-final.pdf

(2006).[13] At present, the problem is particularly acute for cold-adapted species in the Arctic and Antarctic, such as the polar bear and some species of seals and penguins, where sea ice is rapidly diminishing. NAS Report, supra, at 212.

Species adapted to mountaintops are also diminishing rapidly as boreal forests invade their tundra habitat. Parmesan, supra, at 649. Tropical coral reefs and amphibians have likewise been severely negatively affected as global warming both raises water temperatures and alters the ocean's chemical composition. Id. at 649-50. Recent studies indicate that rapidly rising greenhouse gas concentrations are driving natural ocean systems toward conditions not seen for millions of years, with an associated risk of "fundamental and irreversible ecological transformation." Ove Hoegh-Guldberg, et al., The Impact of Climate Change on the World's Marine Ecosystems, 328 Science 1523 (2010);[14] see also William W.L. Chung et al., Projecting Global Marine Biodiversity Impacts Under Climate Change Scenarios, Fish & Fisheries 235-51 (2009) (climate change threatens "dramatic species turnovers of over 60 percent of the present biodiversity, implying ecological disturbances that could potentially disrupt ecosystem services").[15] The IPCC estimates that 20 to 30 % of plant and animal species assessed to date are likely to be at a high risk of extinction as global average temperatures increase. NAS Report, supra, at 213. Numerous species of amphibians, butterflies, mammals, and coral have already been documented as declining drastically due to climate-related impacts, and many more are at great risk of such declines in the foreseeable future. See Parmesan, supra, at 653. Accordingly, the federal agencies charged with implementing the Endangered Species Act, 16 U.S.C. §§ 1531-1544, have already listed a number of species as endangered or threatened due to climate change effects, see, e.g., 71 Fed. Reg. 26,852 (May 9, 2006) (corals); 73 Fed. Reg. 28,212 (May 15, 2008) (Polar bear), and have formally proposed the listing of other such species. See, e.g., 75 Fed. Reg. 77,476 (Dec. 10, 2010) (Ringed seal); 75 Fed. Reg. 61,872 (Oct. 6, 2010) (Atlantic sturgeon).

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[13] Available at http://www.law.arizona.edu/adaptationconference/PDFs/ParmesanAREES_Impacts2006.pdf

[14] Available at http://www.sciencemag.org/content/328/5985/1523.abstract

[15] Available at http://clme.iwlearn.org/clme-groups/tda-ttt/copy_of_reference-materials/projecting-global-marine-biodiversity-impacts-under-climate-change-scenarios

In sum, the IPCC has identified certain "key vulnerabilities" of climate change impacts. See generally Schneider et al., Chapter 19: Assessing Key Vulnerabilities And The Risk From Climate Change, in, AR4, based on the timing of impacts, persistence and reversibility of impacts, likelihood (estimates of uncertainty) of impacts, potential for adaptation, distributional aspects of impacts and vulnerabilities, and importance of the system(s) at risk. Id. at 781. The IPCC has concluded that global mean temperature changes would exacerbate key vulnerabilities associated with many climate-sensitive systems, including food supply, infrastructure, health, water resources, coastal systems, ecosystems, global biogeochemical cycles, ice sheets, and modes of oceanic and atmospheric circulation, and trigger others, such as reduced food security in many low latitude nations. Id.

Specifically, as examples of "key vulnerabilities" of climate change, the IPCC has noted increases in aggregate health impacts from malnutrition, diarrhoeal diseases, infectious diseases, floods and droughts, extreme heat, and other sources of risk; increase in severity of floods, droughts, erosion, water-quality deterioration; extension of areas of salinisation of groundwater due to sea level rise decreasing freshwater availability in coastal areas and resulting in reduced water supplies for hundreds of millions of people; increase in human migration and conflict due to increased drought, water shortages, and riverine and coastal
Flooding; high risk of extinction of several species; increase in coral bleaching and mortality; increase in Category 4-5 storms, flash-flooding, droughts, and fire frequency. Id. at 787-789. Having analyzed the severe impacts and key vulnerabilities of climate change, the IPCC has emphasized that "[a]ctions to mitigate climate change and reduce greenhouse gas emissions will reduce the risk associated with most key vulnerabilities. Postponement of such actions, in contrast, generally increases risks." Id. at 782 (emphasis added).

Absent immediate action to reduce carbon dioxide emissions, atmospheric carbon dioxide could reach levels as high as about 1000 ppm and a temperature increase of up to 5°C by 2100. Id. Life as we know it is unsustainable at these levels. We not only continue to add GHGs into the atmosphere at a rate that outpaces their removal through natural processes, but the current and projected carbon dioxide increase, is about a hundred times faster than has occurred over the past 800,000 years. Nat'l Science Found. et al., Impacts of Ocean Acidification on Coral Reefs and Other Marine Calcifiers: A Guide for Future Research at 3 (June 2006) (emphasis added)

("The rate of current and projected CO_2 increase is about 100x faster than has occurred over the past 650,000 years.").[16]

This increase has to be considered in light of the lifetime of GHGs in the atmosphere. In particular, as Dr. James Hansen explains, a substantial portion of every ton of carbon dioxide emitted by humans persists in the atmosphere for as long as a millennium or more. See TS Endangerment Findings at 16 ("Carbon cycle models indicate that for a pulse of CO_2 emissions, given an equilibrium background, 50% of the atmospheric increase will disappear within 30 years, 30% within a few centuries, and the last 20% may remain in the atmosphere for thousands of years."); see generally James E. Hansen et al., The Case for Young People and Nature: A Path to a Healthy, Natural, Prosperous Future (May 2011) ("Hansen May 2011) (enclosed as "Attachment A").

The concentrations of GHGs in the atmosphere therefore are the cumulative result of historic and current emissions – thus even if global carbon dioxide emissions were instantaneously halted – i.e., if fossil fuel emissions and deforestation were abruptly terminated in 2011 -- it would still take until around 2060 before carbon dioxide levels would decline to below 350 ppm. See id. Atmospheric carbon dioxide levels are currently on a path to reach over 400 ppm by 2020. See generally James E. Hansen & Makiko Sato, Paleoclimate Implications for Human-Made Climate Change (2011) ("Hansen & Sato 2011").[17] If global fossil fuel carbon dioxide emissions continue to grow at the rate of the past decade (about two % per year) up until the time that emissions are terminated, and termination does not occur until 2030, when carbon dioxide levels have reached about 450 ppm, carbon dioxide would not return to 350 ppm until about 2250, even if deforestation emissions were halted in 2010. See generally Hansen May 2011. With a 40-year delay (to 2050), carbon dioxide levels would surpass 500 ppm, and would not return to 350 ppm until around year 3000. See generally Hansen & Sato 2011.

To protect and preserve Earth's climate for the Petitioners and other children, Earth's energy balance must be restored. As Dr. Hansen explains, scientists have accurately calculated how Earth's energy balance will change if we reduce long-lived GHGs such as carbon dioxide.

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[16] Available at http://www.ucar.edu/communications/Final_acidification.pdf

[17] Available at http://www.columbia.edu/~jeh1/mailings/2011/20110118_MilankovicPaper.pdf

Humans are currently causing a planetary energy imbalance of approximately six-tenths of one watt. James E. Hansen et al., Earth's Energy Imbalance and Implications 25 (2011).[18] We would need to reduce carbon dioxide by about 40 ppm to increase Earth's heat radiation to space by six-tenths of one watt, if the net non-carbon dioxide forcing continues to be roughly zero. Id. That reduction would bring the atmospheric carbon dioxide amount back to about 350 ppm. The best available science also shows that to protect Earth's natural systems, average global peak surface temperature must not exceed 1°C above pre-industrial temperatures this century. See generally 2011 Hansen & Sato. To prevent global heating greater than 1°C and to protect Earth's oceans (an essential harbor of countless life forms and absorber of GHGs), concentrations of atmospheric carbon dioxide must decline to less than 350 ppm by the end of this century. Id. To have the best chance at reducing carbon dioxide levels in the atmosphere to 350 ppm by the end of the century, best available science concludes that carbon dioxide emissions must peak in 2012 and must begin to decline at a global average of at least 6 % each year, beginning in 2013, through 2050. See generally Hansen May 2011.

Additionally, climate change is accelerating the destruction of forest resources. Changes in climate are altering forests and will inevitably cause further, more dramatic changes both directly -- through the responses of trees to altered temperature and moisture -- and indirectly, through shifting patterns of fire, insects, and disease, which are generally expected to increase in extent and severity. Rick Brown, Defenders of Wildlife, for the National Forest Restoration Collaborative, Impacts of Climate Change for Conservation, Restoration and Management of National Forest Land 1 (Apr. 22, 2010) ("Climate Change & Forest Conservation").[19]

Improved forestry and agricultural practices, for example, can provide a net drawdown of atmospheric carbon dioxide, primarily via reforestation of degraded lands that are of little or no value for agricultural purposes, helping to return us to 350 ppm somewhat sooner than we could with emission reductions alone. See generally James E. Hansen et al., Target Atmospheric CO2:

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[18] Available at http://www.columbia.edu/~jeh1/mailings/2011/20110415_EnergyImbalancePaper.pdf

[19] Available at http://www.defenders.org/resources/publications/programs_and_policy/biodiversity_partners/implications_of_climate_change_for_conservation,_restoration_and_management_of_national_forest_lands.pdf

Where Should Humanity Aim? 2 Open Atmos. Sci. J. 217–31. (2008).[20] Carbon sequestering forests and soils must be preserved and replanted, oceans must be protected and agricultural practices must improve. See Hansen May 2011 at 10. These reductions are necessary to draw down the excessive carbon dioxide from the atmosphere and to fulfill the state's public trust responsibilities.

B. Maryland Is One Of The Most Vulnerable States To Climate Change And Sea Level Rise In The United States.

Maryland is one of the most vulnerable states to sea- level rise in the United States. See James G. Titus & Charlie Richman, Maps of Lands Vulnerable to Sea Level Rise: Modeled Elevations along the U.S. Atlantic and Gulf Coasts, at 1.[21] In the last century, Maryland has experienced rising temperatures, increased precipitation, more severe weather events, and a rise in sea level. See Md. Comm'n on Climate Change, Climate Change Impacts on Maryland and the Cost of Inaction, in Md Climate Change Action Plan at 11. Average annual temperatures for the Mid-Atlantic region have increased by .5-1°F (.3-.6°C) since 1900, which is more than the global average, while Maryland's average annual temperature has increased about 2° F (1° C). Id. The average temperature of the Chesapeake Bay has warmed by 2°F over the same time period. Id. Average precipitation has increased by 10 % throughout most of Maryland, and the sea level along the Maryland coastline has risen at a rate of 3-4 mm/year (.14 inch/year) over the last century – a rate that is nearly twice the global average. Id. The Maryland Commission on Climate Change, established in 2007 and charged with collectively developing a "climate change action plan" to address climate change in Maryland, has warned that:

> **These trends are predicted to continue or worsen if climate change progresses unchecked.** Average yearly temperatures are expected to increase by 3-6°F (2-4°C) in the winter and by 4-8° F (2.2-4.4°C) in the summer. Precipitation will increase by 20 per cent in Maryland with more rainfall in the winter and less in the spring. As climate change raises ocean temperatures, alters weather patterns, and contributes to the melting of polar icecaps and subsequent sea level rise, Maryland can expect significant coastal impacts. Major coastal storms will be more intense and more frequent. By century's end, 5-15 per cent more late-winter

[20] Available at http://pubs.giss.nasa.gov/cgi-bin/abstract.cgi?id=ha00410c
[21] Available at, http://epa.gov/climatechange/effects/downloads/maps.pdf

> storms may develop in the Northeast as storm systems move further north in response to warmer ocean surface temperatures. Perhaps most significant to Maryland, sea level rise will increase by .6-1.22 m (24-48 inches) over the next century along the coast.

Id. at 11-12 (emphasis added) (internal citations omitted). "Maryland has experienced considerable shoreline erosion and deterioration of coastal wetlands which are a critical component of its bays and estuaries." See Md. Comm'n on Climate Change, Comprehensive Assessment of Climate Change Impacts in Maryland, in Md Climate Change Action Plan at 3. "Increased winter-spring runoff would wash more nutrients into the [Chesapeake and Coastal] Bays, and higher temperatures and stronger density stratification in the estuaries would tend to exacerbate water quality impairment," and "[l]iving resources will very likely change in species composition and abundance with warming." Id. at 3-4. For instance, "[a]s ocean water becomes more acidic, shellfish production could be affected." Id. at 4. Further, the Maryland Commission on Climate Change has observed that "[h]ealth risks due to heat stress are very likely to increase, if emissions are not reduced." Id.

Climate change is also having and will continue to have, a serious impact on forests in Maryland. The Department itself has noted that "[e]very acre of forest in Maryland is potentially subject to alteration" due to climate change. 2010 Md. Forest Assessment at 26 - 27. The Maryland Commission on Climate Change has found that climate change will result in degradation of forests in Maryland as "the composition of Maryland forests is likely to undergo pronounced changes," and "heat stress, seasonal droughts, and outbreaks of pests and diseases are likely to diminish forest productivity," concluding that "this could result in impairment of important ecosystem services that forests provide, including carbon sequestration, control of the water cycle, and maintenance of biodiversity." See Md. Comm'n on Climate Change, Comprehensive Assessment of Climate Change Impacts in Maryland, in Md Climate Change Action Plan at 47-48 (emphasis added); see also 2010 Md. Forest Assessment at 8 (noting that climate change is expected "to change the composition of Maryland's forests" to more pine as sugar maple, beech, hemlock and oak-hickory decline).

If State agencies, including the Department, do not immediately address the climate change crisis and act swiftly to reduce human-caused carbon dioxide emissions into the atmosphere, the environment in which humans and other life have thrived will be catastrophically and irreparably damaged, and Petitioners and future generations of children will face mass suffering on a planet that may be largely uninhabitable. We must protect and preserve the planet for these children and future generations. Without immediate action, the catastrophic collapse of natural systems is inevitable. To return Earth's energy balance, and to protect its natural systems, the Department must fulfill its public trust obligation to protect the State's critical natural resources in order to do its part in achieving the scientifically-established goal of 350 ppm atmospheric carbon dioxide concentrations by the end of this century.

C. Deforestation Is A Double-edged Sword – It Releases Carbon Dioxide Into The Atmosphere and Destroys The Ability Of Forests To Sequester / Store Carbon.

Forests influence the rate and extent of climate change by absorbing carbon dioxide from the atmosphere and storing it in wood and soils -- all living forests absorb carbon dioxide -- or by releasing carbon dioxide to the atmosphere -- carbon dioxide is released whenever land is converted to non-forest uses or disturbed by activities such as logging. "The relative balance between the two processes determines whether a forest is a source or sink of CO2." Climate Change & Forest Conservation at 1. U.S. forests store about 152,236 million metric tons (MMT) of carbon dioxide, representing about 2 % of global terrestrial carbon stores. Ann L. Ingerson, U.S. Forest Carbon and Climate Change 2 (The Wilderness Society, 2007).[22] Though deforestation is occurring much more rapidly than forest growth globally, forests in the United States currently remove substantially more carbon from the atmosphere than they emit, so our forest-related carbon sink is increasing by about 699 MMT of carbon dioxide annually (a growth rate of 0.4 %). Climate Change & Forest Conservation at 1.

The Union of Concerned Scientists estimates that carbon sequestration by U.S. forests offsets between 20 - 46 % of the country's GHG emissions. Toni Johnson, Deforestation and Greenhouse-Gas Emissions (Dec. 2009).[23] Forests "will be most effective in mitigating emissions in the near term (the next decade or two), which climate scientists have identified as a crucial period if we are to avoid potentially catastrophic changes in climate." Id. "[Forests] remove CO2 from the atmosphere through photosynthesis, storing (sequestering) the carbon

[22] Available at http://wilderness.org/files/ForestCarbonReport_0.pdf
[23] Available at http://www.cfr.org/natural-resources-management/deforestation-greenhouse-gas-emissions/p14919

primarily as wood and other biomass, and in soil." Id. at 7. "These stores are referred to as a carbon pool, stock, or reservoir. Globally, forests account for about one-half of terrestrial carbon stores, and, taken as a whole, they store carbon in roughly equal amounts above and below ground in the U.S. Id. (internal citations omitted). "Because forests can both store and emit CO2, they can contribute to [climate change] mitigation strategies" i.e., "practices that reduce emissions of greenhouse gases or help remove them from the atmosphere[.]" Climate Change & Forest Conservation at 8.

About 16% of annual global GHG emissions result from deforestation and logging. Conservation Int'l, Deforestation, Logging and GHG Emissions: Current Facts 1 (Dec. 3, 2009).[24] This estimate includes carbon dioxide emissions from the logging and clearing of forests. Id. "Large existing stores of carbon are released into the atmosphere when land is converted to other uses," "essentially negating the entire contribution of plants to the land-based carbon sink." Ingerson, supra at 1. Deforestation also eliminates the significant benefit of forests as carbon sinks "that play a vital role in the mitigation of global warming," id., because forests are important both for their large existing reservoirs of carbon (referred to as "carbon stocks") and the ongoing net flow of carbon from the atmosphere into that forest reservoir (referred to as "carbon sinks"). Id. (emphasis added). Thus, cutting down forests is a double edged sword – it exacerbates and perpetuates the climate crisis by releasing more carbon dioxide into the atmosphere and it also destroys carbon sinks that can absorb carbon dioxide form the atmosphere. See John Meyer, Using the Public Trust Doctrine to Ensure the National Forests Protect the Public from Climate Change, 16 Hastings W.-Nw. J. Envtl. L. & Pol'y 195, 203-204 (2010) ("Public Trust and National Forests") (enclosed as "Attachment B").

In the United States, reduction in deforestation is a widely-recognized means, along with concrete measures to reduce GHG emissions, to avoid the risks of climate change. Amy L. Luers, Union of Concerned Scientists et al., How to Avoid Dangerous Climate Change: A Target for U.S. Emissions Reductions 2 (Sept. 2007).[25] "Given the seriousness of the problems

[24] Available at http://www.conservation.org/Documents/CI_Climate_Deforestation_Logging_Greenhouse_Gas_Emissions_Facts-12-2009.pdf

[25] Available at http://www.ucsusa.org/assets/documents/global_warming/emissions-target-report.pdf

associated with climate change, the need to take mitigation actions sooner rather than later, and the ability of forests to sequester carbon immediately, careful consideration must be given to strategies that optimize the storage of carbon in forests." Climate Change & Forest Conservation at 13.

D. Maryland's Forests Are Being Destroyed To Maximize Timber Production And Development.

Forests make up 39 % of Maryland land cover. 2010 Md. Forest Assessment at 26. The Department has recognized the vast potential of forests in Maryland for sequestering carbon and the need to maintain forests' contribution to global carbon cycles. Id. at 37-38; see also id. at 43 ("Forests help clean air by removing carbon dioxide and pollutants and releasing oxygen. These are normal physiological and biochemical processes of plant metabolism and growth. Along with carbon dioxide, trees remove nitrogen dioxide, carbon monoxide, sulfur dioxide, ozone, and particulate matter from the air. They also reduce and moderate local temperatures, reducing energy demand for artificial cooling (and its accompanying pollution) during peak temperature periods."). Forest carbon pools in Maryland were estimated by the US Forest Service, Northern Research Station in 1997 to be 92.8 million metric tons in biomass. Id. at 38.

However, despite the vast benefits of conserving Maryland's forests, including for much needed carbon sequestration, as recognized by the Department itself, in its most recent survey of forests in Maryland, the United States Forest Service found that "[w]ith increases in urban development and population growth over the last half century, Maryland has lost more than 450,000 acres of forest land" and that "[r]ecent inventories indicate that forest land is still being lost[.]" Lister et al., Maryland's Forest Resources, 2009 3 (U.S. Dep't of Agric., Forest Serv., N. Research Station, 2011);[26] see also U.S. Dep't of Agric., Forest Serv., N. Research Station, Trends in Maryland Forests (2002) (indicating that in 1950 nearly 46% of land in Maryland was under forest cover (comparable to 39 % forest cover today) and that "despite [public programs], declines in forestland area have occurred and are likely to continue in the future, as development

[26] Available at http://nrs.fs.fed.us/pubs/37257

pressures increase on forest as well as farmland.").[27] The United States Forest Service further concluded that "the area in forest [in Maryland] has been declining since the 1960's." Id.

Further, the Department itself has found that "[a]lthough old growth forest was once a dominant feature throughout most of the Maryland landscape, only about 40 small, scattered remnants remain." 2010 Md. Forest Assessment at 18 (emphasis added). The Maryland Alliance for Greenway Improvement & Conservation ("Magic Alliance") has found that the main obstacle to preserving old growth forests is "the structure of institutions that were put in place during a period when this country seemed to offer an endless bounty of natural resources," and, in this context, has observed that county revenues in western Maryland "remain substantially dependent on revenues from timber leases, and the same outdated institutional structure persists at the national level." Magic Alliance, Saving Old Growth Forests.[28] Studies show that untouched "natural forests" store 3 times more carbon than plantation forests on a harvesting schedule. See generally Brendan G. Mackey et al., Green Carbon: The Role of Natural Forests in Carbon Storage 9 (2008) ("Natural Forests Rep.").[29] Further, while "[c]urrent international negotiations are focused on reducing emissions from deforestation and forest degradation [REDD] in developing countries only" experts have concluded that "REDD is also important in the natural forests of countries such as [] the USA." Id.

Further, the forest industry is the fifth largest industry in Maryland, valued at $4 billion. 2010 Md. Forest Assessment at 38. Ninety-two % of forest land in Maryland (2,371,900 acres) is classified as timberland that is potentially available for harvesting. U.S. Dep't of Agric., Forest Serv., N. Research Station, Trends in Maryland Forests (2002).[30] Experts have noted that while "[g]rowing forests usually are sinks that remove carbon from the atmosphere and store it in the form of wood and in soils as products of wood decay," on the other hand "[m]anufacturing wood products" involves "removing wood from the forest pool and processing and relocating

[27] Available at http://www.fs.fed.us/ne/newtown_square/publications/brochures/pdfs/state_forests/md_forest.pdf

[28] Available at http://magicalliance.org/download/saving-old-growth-forests.pdf

[29] Available at http://epress.anu.edu.au/green_carbon_citation.html

[30] Available at http://www.fs.fed.us/ne/newtown_square/publications/brochures/pdfs/state_forests/md_forest.pdf

that wood" which not only does "not remove any more carbon from the atmosphere, [but] it releases carbon to the atmosphere, both from the forest pool and from burning fossil fuels." Climate Change & Forest Conservation at 13.

Nonetheless, the Department continues to permit the logging of Maryland forests without any consideration of the carbon sequestration benefits of forest resources. This "tendency to overlook sequestration opportunities can lead to incorrect and overly pessimistic conclusions about both the cost and feasibility of addressing global climate change in the decades ahead." Cost of U.S. Forest-based Carbon Sequestration at p. ii; see also Ann Ingerson, The Wilderness Society, Wood Products and Carbon Storage: Can Increased Production Help Solve the Climate Crisis? at p.ii (Apr. 2009) ("rather than prioritize forest protection [for carbon storage], much attention has been focused on the potential for wood products and wood fuels to store carbon or reduce fossil emissions.").[31]

IV. THE DEPARTMENT HAS THE NECESSARY LEGAL AUTHORITY TO HALT DEFORESTATION.

As demonstrated below, the Department has the necessary legal authority -- and indeed the duty -- to do its part to avert the climate change crisis by ceasing to permit the destruction of forest resources under its control.

A. The Department Has A Duty To Protect, Preserve And Restore A Healthy Atmosphere Under The Public Trust Doctrine.

"Deriving from the common law of property, the public trust doctrine is the most fundamental legal mechanism to ensure that governments safeguard natural resources necessary for public welfare and survival." Mary Wood, Atmospheric Trust Litigation, in Climate Change Reader 3 (W.H. Rodgers, Jr. & M. Robinson-Dorn eds., Carolina Academic Press, forthcoming 2011).[32] This doctrine has been widely accepted in modern statutory law, see, e.g., National Environmental Policy Act of 1969, 42 U.S.C. § 4331(b)(1) (declaring a national duty to "fulfill the responsibilities of each generation as trustee of the environment for succeeding generations"), and has long been recognized in judicial decisions. See, e.g., Geer v. Conn., 161 U.S. 519, 525-29 (1896), cited in Davis v. State, 390 A.2d 1112, 1116 (Md. 1978), and Stevens

[31] Available at http://wilderness.org/files/Wood-Products-and-Carbon-Storage.pdf.

[32] Available at http://www.law.uoregon.edu/faculty/mwood/docs/atlfinal.doc

v. State, 43 A. 929, 930 (Md. 1899); see also Ill. Cent. R.R. Co. v. Ill., 146 U.S. 387 (1892) (holding that the shoreline of Lake Michigan was held in public trust by the State of Michigan), cited in Lake Roland Elevated Ry. Co. v. City of Balt., 26 A. 510 (Md. 1893).

At its core, the public trust doctrine defines certain natural resources as quantifiable assets that are the "res" or "corpus" of the trust. See Wood, supra at 5. The government holds these resources for the benefit of present and future generations who are the beneficiaries of the trust. Geer, 161 U.S. at 534. Thus, the public trust doctrine applies to natural resources such as the atmosphere, see e.g., id. at 525 (describing "res communes" as "air, the water which runs in the rivers, the sea, and its shores" (emphasis added)), and forests. See e.g., Light v. United States, 220 U.S. 523, 537 (1911) ("the public lands are held in trust for all the people of the United States"); Sierra Club v. U.S. Dep't of the Interior, 398 F. Supp. 284, 293 (1975) (holding the National Park Service to be a "trustee" on behalf of the public and requiring the Park Service to protect the national forests in question from adjacent logging); see also Public Trust and National Forests at 198.

The public trust doctrine is a binding legal principle recognized under Maryland law. See, e.g., Bausch & Lomb Inc. v. Utica Mut. Ins. Co., 625 A.2d 1021, 1035 (Md. 1993) (holding that "although the State is said to be the owner of the navigable waters within its boundaries, it holds them not absolutely, but as a quasi trustee for the public benefit," and citing Balt. City v. Balt. and Phila. Steamboat Co., 65 A. 353 (Md. 1906); Browne v. Kennedy, 5 H. & J. 195 (Md. 1821); Bd. of Pub. Works v. Larmar Corp., 277 A.2d 427 (Md. 1971); and Md. Dep't of Nat. Res. v. Amerada Hess Corp., 350 F.Supp. 1060 (D.Md. 1972)); see also Md. Consti., Decl. of Rights, Art. 5 (recognizing the applicability of common law principles). Pursuant to this doctrine, the State Government is responsible, as perpetual trustee, for the protection and preservation of the atmosphere and forest resources for the benefit of present and future generations. See Md. Consti., Decl. of Rights, Art. 6 ("[A]ll persons invested with the Legislative or Executive powers of Government are the Trustees of the Public, and, as such, accountable for their conduct[.]") (emphasis added) construed in Kerpelman v. Bd. of Pub. Works of Md., 276 A.2d 56 (Md. 1971) ("'Trustees of the Public' in all that they do [] must reasonably exercise this fiduciary duty, particularly in regard to their stewardship of property."); see also Ctr. for Biological Diversity v. FPL Grp., 83 Cal.Rptr.3d 588 (Cal. Ct. App. 2008) (discussing public trust obligations of "public agencies" over wildlife); In Re Water Use Permit Applications, Waihole Ditch Combined Contested Case Hr'g 9 P.3d 409 (Haw. 2000) (applying public trust obligations to state agency).

Further, the 1973 Maryland Environmental Policy Act recognizes the "stewardship role" of state agencies under which the Department is required to "conduct [its] affairs with an awareness that [it is a] steward[] of the air, land, water, living and historic resources," and fully carry out its "obligation to protect the environment for the use and enjoyment of this and all future generations." Md. Code, Nat. Res. Art., § 1-302(c) (emphasis added), construed in Bausch & Lomb, 625 A.2d at 1035 (Md. 1993) (explaining that "a steward is one who cares for the property or interests of another."). "Taken collectively, with due regard to the statutes' articulation of the State's interests in preserving the environment, these legislative pronouncements demonstrate that the State has committed itself to regulatory oversight of the [natural resources] of Maryland to benefit its citizens." Bausch & Lomb, 625 A.2d at 1035 (emphasis added); see also Davis v. State, 390 A.2d 1112, 1113, 1116 (Md. 1978) (interpreting the Natural Resources Article of the Maryland Code, "[t]he General Assembly has declared the intention to insure the preservation, development, wise use, and enjoyment of all the natural resources for greatest benefits to the state and its citizens. To this end it created the Department of Natural Resources of Maryland as a principal department of the state government… The legislative scheme expressed by the Natural Resources Article is to effectuate conservation of the natural resources of the State, a legitimate local public interest." (internal citations omitted)).

Petitioners urge the Department to execute its mandatory duty under the public trust doctrine which requires it to hold vital natural resources in "trust" for present and future generations of its citizens. As trustee of the atmosphere, the Department has a fiduciary and ongoing affirmative duty to preserve and protect this resource for Petitioners and future generations as beneficiaries of this trust asset. The public trust imposes a duty on the Department to affirmatively preserve and protect the people's trust assets from damage or loss, and not to use the asset in a manner that causes injury to the trust beneficiaries, both present and future. See Bausch & Lomb Inc. v. Utica Mut. Ins. Co., 625 A.2d 1021, 1033-1035 (Md. 1993). Consequently, the Department has an affirmative fiduciary duty to prevent waste, to use reasonable skill and care to preserve the trust property, and to maintain trust assets. The

Department's fiduciary duty in this instance is defined by scientists' concrete prescriptions for carbon reductions. The Department must manage the atmospheric trust in a way that will help preserve its healthy balance, to the greatest extent possible.

B. The Department Also Has Statutory Authority To Protect State Forests For The Purpose Of Mitigating Climate Change.

In addition to its obligation under the public trust doctrine, the Department has authority under current State law to take necessary action to protect the forests from further destruction. The Maryland General Assembly has found that State forests are "basic assets and their proper use, development, and preservation are <u>necessary to protect and promote the health, safety, economy, and general welfare of the people of the State</u>." Md. Code Ann., Nat. Res. § 5-102(a)(1) (emphasis added). The State has adopted a "No Net Loss of Forest Policy," and the Department is required to cooperate with forestry-related stakeholder groups to "[d]evelop proposals for the creation of a policy of no net loss of forest in the State." <u>Id.</u> § 5-104(a)(2).

Specifically, the Maryland General Assembly has found that "<u>[f]orests and trees are key indicators of climate change and can mitigate greenhouse gas emissions by carbon sequestration</u>[.]" <u>Id.</u> § 5-102(a)(3) (emphasis added). The State has vested in the Department broad and overarching responsibility to "promote, administer, and manage" the State's forests. <u>Id.</u> § 5-201(a). In carrying out this responsibility over the State forest resources, the Department has the statutory authority to make rules and regulations for the protection of the State forests. <u>Id.</u> § 5-209(a).

Despite a statutory mandate to protect State forests and recognition by the Department itself that forests resources mitigate climate change, <u>see e.g.</u>, Md. Dep't of Nat. Res., Forest Serv., <u>Maryland Forest Resource Assessment</u> 8 (June 18, 2010) ("2010 Md. Forest Assessment") ("Larger tree volumes contribute to carbon sequestration as wood is left standing, but this could be increased with additional forest management."), the Department has largely failed to implement this mandate by continuing to permit extensive logging in State forests, under State forestry regulations that were enacted decades ago and did not contemplate the disastrous climate change impacts that are continuing to affect Maryland. <u>Cf.</u> Public Trust and National Forests at 197-198 (urging the U.S. Forest Service to amend federal forestry regulations for the same reason).

The current system for management of forests by the Department and the permitting requirements under applicable forestry regulations do not take into consideration the GHG emissions from cutting down forests and does not account for the carbon sequestration benefits of forests in Maryland. See e.g., Md. Code Ann., Nat. Res. § 5-608(a) (procedure for issuing "forest product operator's license" to all forest products manufacturing plants, sawmills, loggers, and firewood operators for the harvest, manufacture or sale of forest products); see also id. § 5-101(l) (defining "Sustainable forestry or sustainable forestry management" as an "accepted and applied stewardship concept for the use of forests and forest lands in a manner and at a rate that maintains a forest's biodiversity; productivity; regeneration capacity; nutrient reduction benefits; vitality; and ecological, economic, and social purposes at local and national levels that do not cause damage to other ecosystems.").

In general, the regulations on logging, enacted decades ago much before the serious implications of climate change in Maryland were recognized, ignore the contribution of deforestation to climate change. See e.g., Md. Dep't of Nat. Res., Guide to Maryland's Regulation of Forestry and Related Practices 10-11 (Dec. 2001) ("Forestry Guide") (citing Md. Code Ann., Nat. Res. §§ 5-409, 5-605, 5-606, 5-608 and describing the requirements for a person who harvests timber as follows: "Leave conditions favorable for regrowth; Leave young growth; Arrange for restocking the land after cutting by leaving trees of desirable species of suitable size singly, or in groups, well distributed and in a number to secure restocking; Maintain adequate growing stock after partial cutting or selective logging.") Specifically, restrictions on deforestation focus mostly on sediment control or sediment pollution thus requiring approval of a sediment and erosion control plan for all commercial harvests of woodlands on 5,000 square feet of disturbed area, or on an area that crosses any perennial or intermittent watercourse. See generally id. Envir. §§ 4-l0l - 4-l16, 4-401 - 4-417; see also Maryland Forest Conservation Act of 1991, Md. Code Ann., Nat. Res. §§ 5-1601 – 1613 ("Forest Conservation Act"); Forestry Guide at 11-19. The crux of the Forest Conservation Act is that it requires local governments to protect and maintain forest resources by approving - prior to development / deforestation/commercial timber harvest and logging operations on forest land - a "Forest Conservation Plan" that is developed by a licensed forester, licensed landscape architect, or other qualified professionals. See Forest Conservation Act, §§ 5-1602 - 1605. While the Act and the agency regulations adopted therein describe the requirements for such conservation plans, these requirements entirely ignore the benefits of forests as "carbon sinks." See generally Forest Conservation Act; Forestry Guide.

Consequently, the entire permitting process for logging in State forests fails to take into account the use of such forests for carbon sequestration and mitigation of climate change. Therefore, a new science-based approach with specific, measurable, and enforceable standards is needed for the Department to help avert the extensive and catastrophic climate change impacts that are predicted. See Public Trust and National Forests at 197-198. Thus, the Department must integrate "the goal of carbon storage" with "traditional goals such as water, wildlife, recreation, and wood products," id., while discharging its statutory responsibility to protect the forests in Maryland and its fiduciary duty under the public trust doctrine to manage State forests in a way that protects Petitioners and other children of Maryland from the devastating impacts of climate change.

V. CONCLUSION

Given the serious impacts of climate change in Maryland that are already occurring and that will continue to increase at an alarming rate, the Department must re-evaluate the existing forest management structures, regulations and policies, and change the existing regulatory regime to protect the State's forest resources as carbon sinks. The Department must, as expeditiously as possible, exercise its fiduciary duty under the public trust doctrine and implement effective measures to facilitate this important benefit of forests in order to maximize carbon sequestration – an effective way to mitigate climate change along with GHG emission reduction measures. If the Department, as the trustee of this vital natural resource – the atmosphere -- does not take immediate action to do its part to protect, preserve and bring the atmosphere back into balance, the people of Maryland, and especially its children, will continue to suffer devastating environmental, health and social consequences.

Specifically, Petitioners respectfully request that the Department:

1) issue an immediate moratorium on all further logging in forests owned by the State of Maryland;

2) concurrently establish criteria and standards, that take into account the effects of deforestation on climate change, in all future decisions involving the permitting of logging on private lands;
3) develop an effective and transparent system for measuring, reporting and verifying anthropogenic forest-related emissions from GHG sources, such as logging activities, and the impact of removal of forest carbon sinks, forest carbon stocks, and any other forest-area changes; and
4) adopt measures, including afforestation and reforestation, to both maintain existing forests and carbon stocks and to increase and enhance forest-based carbon sinks.

Sincerely,

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ATTACHMENT A

James Hansen et al., The Case for Young People and Nature: A Path to a Healthy, Natural, Prosperous Future (May 2011)

The Case for Young People and Nature: A Path to a Healthy, Natural, Prosperous Future

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Abstract. We describe scenarios that define how rapidly fossil fuel emissions must be phased down to restore Earth's energy balance and stabilize global climate. A scenario that stabilizes climate and preserves nature is technically possible and it is essential for the future of humanity. Despite overwhelming evidence, governments and the fossil fuel industry continue to propose that all fossil fuels must be exploited before the world turns predominantly to clean energies. If governments fail to adopt policies that cause rapid phase-down of fossil fuel emissions, today's children, future generations, and nature will bear the consequences through no fault of their own. Governments must act immediately to significantly reduce fossil fuel emissions to protect our children's future and avoid loss of crucial ecosystem services, or else be complicit in this loss and its consequences.

1. Background

Humanity is now the dominant force driving changes of Earth's atmospheric composition and thus future climate on the planet. Carbon dioxide (CO_2) emitted in burning of fossil fuels is, according to best available science, the main cause of global warming in the past century. It is also well-understood that most of the CO_2 produced by burning fossil fuels will remain in the climate system for millennia. The risk of deleterious or even catastrophic effects of climate change driven by increasing CO_2 is now widely recognized by the relevant scientific community.

The climate system has great inertia because it contains a 4-kilometer deep ocean and 2-kilometer thick ice sheets. As a result, global climate responds only slowly, at least initially, to natural and human-made forcings of the system. Consequently, today's changes of atmospheric composition will be felt most by today's young people and the unborn, in other words, by people who have no possibility of protecting their own rights and their future well-being, and who currently depend on others who make decisions today that have consequences over future decades and centuries.

Governments have recognized the need to stabilize atmospheric composition at a level that avoids dangerous anthropogenic climate change, as formalized in the Framework Convention on Climate Change in 1992. Yet the resulting 1997 Kyoto Protocol was so ineffective that global fossil fuel emissions have since accelerated by 2.5% per year, compared to 1.5% per year in the preceding two decades.

Governments and businesses have learned to make assurances that they are working on clean energies and reduced emissions, but in view of the documented emissions pathway it is not inappropriate to describe their rhetoric as being basically 'greenwash'. The reality is that most governments, strongly influenced by the fossil fuel industry, continue to allow and even

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subsidize development of fossil fuel deposits. This situation was aptly described in a special energy supplement in the New York Times entitled 'There Will Be Fuel' (Krauss, 2010), which described massive efforts to expand fossil fuel extraction. These efforts include expansion of oil drilling to increasing depths of the global ocean, into the Arctic, and onto environmentally fragile public lands; squeezing of oil from tar sands; hydro-fracking to expand extraction of natural gas; and increased mining of coal via mechanized longwall mining and mountain-top removal.

The true costs of fossil fuels to human well-being and the biosphere is not imbedded in their price. Fossil fuels are the cheapest energy source today only if they are not made to pay for their damage to human health, to the environment, and to the future well-being of young people who will inherit on-going climate changes that are largely out of their control. Even a moderate but steadily rising price on carbon emissions would be sufficient to move the world toward clean energies, but such an approach has been effectively resisted by the fossil fuel industry.

The so-called 'north-south' injustice of climate disruption has been emphasized in international discussions, and payment of $100B per year to developing countries has been proposed. Focus on this injustice, as developed countries reap the economic benefits of fossil fuels while developing countries are among the most vulnerable to the impacts of climate change, is appropriate. Payments, if used as intended, will support adaptation to climate change and mitigation of emissions from developing countries. We must be concerned, however, about the degree to which such payment, from adults in the North to adults in the South, are a modern form of indulgences, allowing fossil fuel emissions to continue with only marginal reductions or even increase.

The greatest injustice of continued fossil fuel dominance of energy is the heaping of climate and environmental damages onto the heads of young people and those yet to be born in both developing and developed countries. The tragedy of this situation is that a pathway to a clean energy future is not only possible, but even economically sensible.

Fossil fuels today power engines of economic development and thus raise the standards of living throughout most of the world. But air and water pollution due to extraction and burning of fossil fuels kills more than 1,000,000 people per year and affects the health of billions of people **(**Cohen et al., 2005**)**. Burning all fossil fuels would have a climate impact that literally produces a different planet than the one on which civilization developed. The consequences for young people, future generations, and other species would continue to mount over years and centuries. Ice sheet disintegration would cause continual shoreline adjustments with massive civil engineering cost implications as well as widespread heritage loss in the nearly uncountable number of coastal cites. Shifting of climatic zones and repeated climate disruptions would have enormous economic and social costs, especially in the developing world.

These consequences can be avoided via prompt transition to a clean energy future. The benefits would include a healthy environment with clean air and water, preservation of the shorelines and climatic zones that civilization is adapted to, and retention of the many benefits humanity derives from the remarkable diversity of species with which we share this planet.

It is appropriate that governments, instituted for the protection of all citizens, should be required to safeguard the future of young people and the unborn. Specific policies cannot be imposed by courts, but courts can require governments to present realistic plans to protect the rights of the young. These plans should be consistent with the scientifically-established rate at which emissions must be reduced to stabilize climate.

Science can also make clear that rapid transition to improved energy efficiency and clean energies is not only feasible but economically sensible, and that rapid transition requires a steadily rising price on undesirable emissions. Other actions by governments are needed, such as

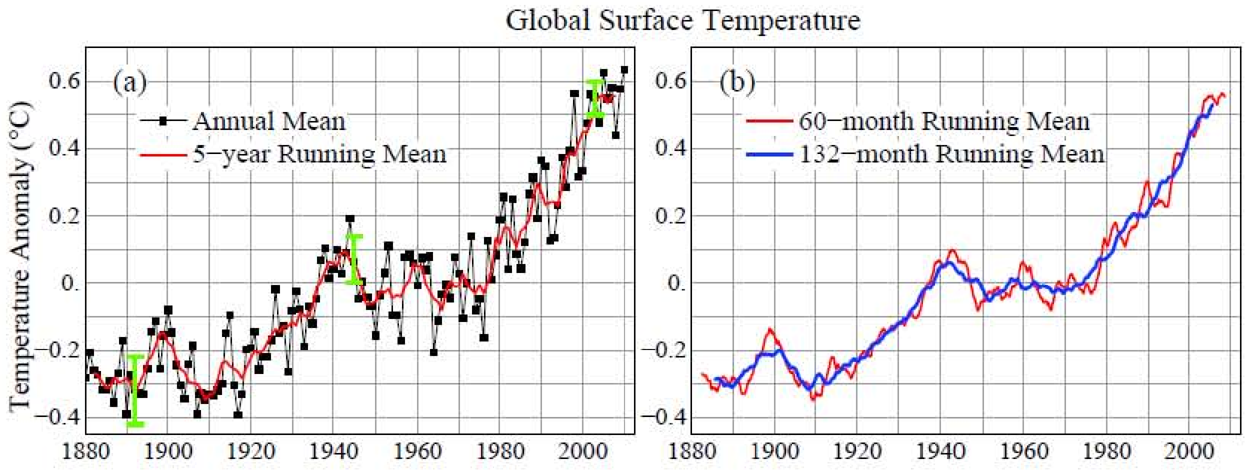

Figure 1. Global surface temperature anomalies relative to 1951-1980 mean for (a) annual and 5-year running means through 2010, and (b) 60-month and 132-month running means through March 2011. Green bars are 2-σ error estimates, i.e., 95% confidence intervals (data from Hansen et al., 2010).

enforcement of energy efficiency standards and investment in technology development. However, without the underlying incentive of a price on carbon emissions, such actions, as well as voluntary actions by concerned citizens, are only marginally effective. This is because such actions reduce the demand for fossil fuels, lower their price, and thus encourage fossil fuel use elsewhere. The price on carbon emissions, to be most effective, must be transparent and across-the-board, for the sake of public acceptance, for guidance of consumer decisions, and for guidance of business decisions including technology investments.

Here we summarize the emission reductions required to restore Earth's energy balance, limit CO_2 change to a level that avoids dangerous human-made interference with climate, assure a bright future for young people and future generations, and provide a planet on which both humans and our fellow species can continue to survive and thrive.

2. Global Temperature

Global surface temperature fluctuates chaotically within a limited range and it also responds to natural and human-made climate forcings. Climate forcings are imposed perturbations of Earth's energy balance. Examples of climate forcings are changes in the luminosity of the sun, volcanic eruptions that inject aerosols (fine particles) into Earth's stratosphere, and human-caused alterations of atmospheric composition, most notably the increase of atmospheric carbon dioxide (CO_2) due to burning of fossil fuels.

2.1. Modern Temperature

Figure 1(a) shows annual-mean global temperature change over the past century. The year-to-year variability is partly unforced chaotic variability and partly forced climate change. For example, the global warmth of 1998 was a consequence of the strongest El Nino of the century, a natural warming of the tropical Pacific Ocean surface associated with a fluctuation of ocean dynamics. The strong cooling in 1992 was caused by stratospheric aerosols from the Mount Pinatubo volcanic eruption, which temporarily reduced sunlight reaching Earth's surface by as much as 2 percent.

Figure 1(b) shows global temperature change averaged over 5 years (60 months) and 11 years (132 months), for the purpose of minimizing year-to-year variability. The rapid warming during the past three decades is a forced climate change that has been shown to be a consequence of the simultaneous rapid growth of human-made atmospheric greenhouse gases, predominately CO_2 from fossil fuel burning (IPCC, 2007).

The basic physics underlying this global warming, the greenhouse effect, is simple. An increase of gases such as CO_2 makes the atmosphere more opaque at infrared wavelengths. This added opacity causes the planet's heat radiation to space to arise from higher, colder levels in the atmosphere, thus reducing emission of heat energy to space. The temporary imbalance between the energy absorbed from the sun and heat emission to space, causes the planet to warm until planetary energy balance is restored.

The great thermal inertia of Earth, primarily a consequence of the 4-kilometer (2½ mile) deep ocean, causes the global temperature response to a climate forcing to be slow. Because atmospheric CO_2 is continuing to increase, Earth is significantly out of energy balance – the solar energy being absorbed by the planet exceeds heat radiation to space. Measurement of Earth's energy imbalance provides the most precise quantitative evaluation of how much CO_2 must be reduced to stabilize climate, as discussed in Section 2.

However, we should first discuss global temperature, because most efforts to assess the level of climate change that would be 'dangerous' for humanity have focused on estimating a permissible level of global warming. Broad-based assessments, represented by the 'burning embers' diagram in IPCC (2001, 2007), suggested that major problems begin with global warming of 2-3°C relative to global temperature in year 2000. Sophisticated probabilistic analyses (Schneider and Mastrandrea, 2005) found a median 'dangerous' threshold of 2.85°C above global temperature in 2000, with the 90 percent confidence range being 1.45-4.65°C.

The conclusion that humanity could readily tolerate global warming up to a few degrees Celsius seemed to mesh with common sense. After all, people readily tolerate much larger regional and seasonal climate variations.

The fallacy of this logic became widely apparent only in recent years. (1) Summer sea ice cover in the Arctic plummeted in 2007 to an area 30 percent less than a few decades earlier. Continued growth of greenhouse gases will likely cause the loss of all summer sea ice within the next few decades, with large effects on wildlife and indigenous people, increased heat absorption at high latitudes, and potentially the release of massive amounts of methane, a powerful greenhouse gas, presently frozen in Arctic sediments on both land and sea floor. (2) The great continental ice sheets of Greenland and Antarctic have begun to shed ice at a rate, now several hundred cubic kilometers per year, which is continuing to accelerate. With the loss of protective sea ice and buttressing ice shelves, there is a danger that ice sheet mass loss will reach a level that causes catastrophic, and for all practical purposes irreversible, sea level rise. (3) Mountain glaciers are receding rapidly all around the world. Summer glacier melt provides fresh water to major world rivers during the dry season, so loss of the glaciers would be highly detrimental to billions of people. (4) The hot dry subtropical climate belts have expanded, affecting climate most notably in the southern United States, the Mediterranean and Middle East regions, and Australia, contributing to more intense droughts, summer heat waves, and devastating wildfires. (5)) Coral reef ecosystems are already being impacted by a combination of ocean warming and acidification (a direct consequence of rising atmospheric CO_2), resulting in a 1-2% per year decline in geographic extent. Coral reef ecosystems will be eliminated with continued increase of atmospheric CO_2, with huge consequences for an estimated 500 million people that depend on the ecosystem services of coral reefs (Bruno and Selig, 2007; Hoegh-guldberg et al., 2007;

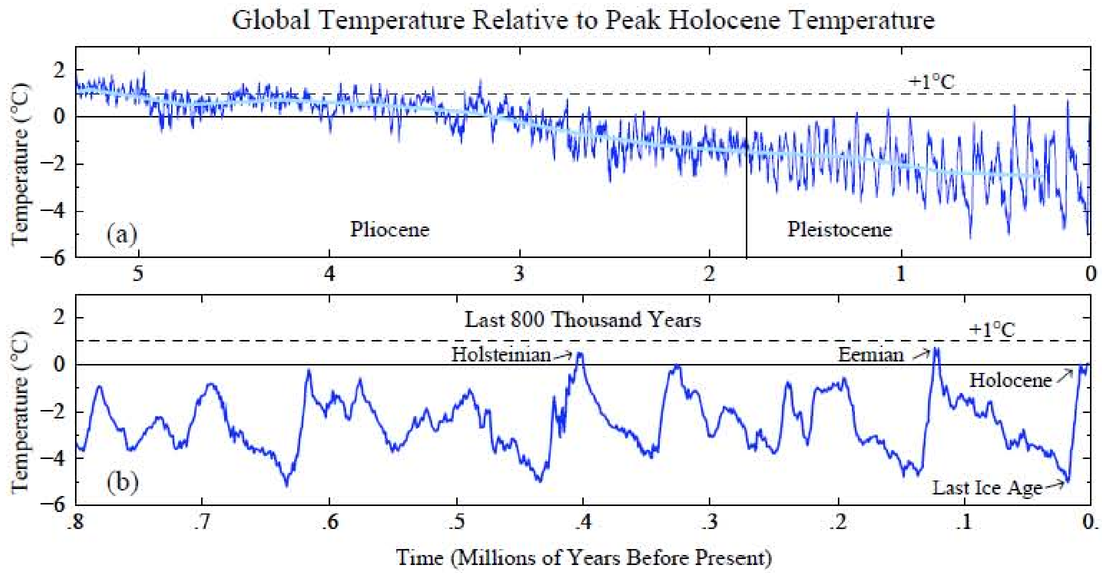

Figure 2. Global temperature relative to peak Holocene temperature (Hansen and Sato, 2011).

Veron et al., 2009). (6) So-called mega-heatwaves have become noticeably more frequent, for example the 2003 and 2010 heatwaves over Europe and large parts of Russia, each with heat-death tolls in the range of 55,000 to 70,000 (Barriopedro et al., 2011).
Reassessment of the dangerous level of global warming has been spurred by realization that large climate effects are already beginning while global warming is less than 1°C above preindustrial levels. The best tool for assessment is provided by paleoclimate, the history of ancient climates on Earth.

2.2. Paleoclimate Temperature

Hansen and Sato (2011) illustrate Earth's temperature on a broad range of time scales. Figure 2(a) shows estimated global mean temperature[8] during the Pliocene and Pleistocene, approximately the past five million years. Figure 2(b) shows higher temporal resolution, so that the more recent glacial to interglacial climate oscillations are more apparent.

Climate variations summarized in Figure 2 are huge. During the last ice age, 20,000 years ago, global mean surface temperature was about 5°C lower than today. But regional changes on land were larger. Most of Canada was under an ice sheet. New York City was buried under that ice sheet, as were Minneapolis and Seattle. On average the ice sheet was more than a mile (1.6 km) thick. Although it was thinner near its southern boundary, its thickness at the location of the above cities dwarfs the tallest buildings in today's world. Another ice sheet covered northwest Europe.

These huge climate changes were instigated by minor perturbations of Earth's orbit about the sun and the tilt of Earth's spin axis relative to the orbital plane. By altering the seasonal and geographical distribution of sunlight, the orbital perturbations cause small temperature change. Temperature change then drives two powerful amplifying feedbacks: higher temperature melts

[8] This estimate of global mean temperature is obtained from ocean sediments at many locations around the world (Zachos et al., 2001; Hansen et al., 2008). The composition of the shells of deep-sea-dwelling microscopic animals (foraminifera), preserved in ocean sediments, carry a record of ocean temperature. Deep ocean temperature change is about two-thirds as large as global mean surface temperature change for the range of climates from the last ice age to the present interglacial period; that proportionality factor is included in Figure 2.

ice globally, thus exposing darker surfaces that absorb more sunlight; higher temperature also causes the ocean and soil to release CO_2 and other greenhouse gases. These amplifying feedbacks have been shown, quantitatively, to be responsible for practically the entire glacial-to-interglacial temperature change.

In these slow natural climate changes the amplifying feedbacks (ice area and CO_2 amount) acted as slaves to weak orbital forcings. But today CO_2, global temperature, and ice area are under the command of humanity: CO_2 has increased to levels not seen for at least 3 million years, global temperature is rising, and ice is melting rapidly all over the planet. Another ice age will never occur, unless humans go extinct. A single chlorofluorocarbon factory can produce gases with a climate forcing that exceeds the forcing due to Earth orbital perturbations.

During the climate oscillations summarized in Figure 2, Earth's climate remained in near equilibrium with its changing boundary conditions, i.e., with changing ice sheet area and changing atmospheric CO_2. These natural boundary conditions changed slowly, over millennia, because the principal Earth orbital perturbations occur on time scales predominately in the range of 20,000 to 100,000 years.

Human-made changes of atmospheric composition are occurring much faster, on time scales of decades and centuries. The paleoclimate record does not tell us how rapidly the climate system will respond to the high-speed human-made change of climate forcings – our best guide will be observations of what is beginning to happen now. But the paleoclimate record does provide an indication of the eventual consequences of a given level of global warming.

The Eemian and Hosteinian interglacial periods, respectively about 130,000 and 400,000 years ago, were warmer than the Holocene, but global mean temperature in those periods was probably less than 1°C warmer than peak Holocene temperature (Figure 2b). Yet it was warm enough for sea level to reach mean levels 4-6 meters higher than today.

Global mean temperature 2°C higher than peak Holocene temperature has not existed since at least the Pliocene, a few million years ago. Sea level at that time was estimated to have been 15-25 meters higher than today. Changes of regional climate during these warm periods were much greater than the global mean changes.

How does today's global temperature, given the warming of the past century, compare with prior peak Holocene temperature? Holocene climate has been highly variable on a regional basis (Mayewski et al., 2004). However, Hansen and Sato (2011) show from records at several places around the globe that mean temperature has been remarkably constant during the Holocene. They estimate that the warming between the 1800s and the period 1951-1980 (a warming of ~0.25°C in the Goddard Institute for Space Studies analysis, Hansen et al., 2010) brought global temperatures back to approximately the peak Holocene level.

If the 1951-1980 global mean temperature approximates peak Holocene temperature, this implies that global temperature in 2000 (5-year running mean) was already 0.45°C above the peak Holocene temperature. The uncertainty in the peak Holocene temperature is a least several tenths of a degree Celsius. However, strong empirical evidence that global temperature has already risen above the prior peak Holocene temperature is provided by the ongoing mass loss of the Greenland and West Antarctic ice sheets, which began within the last 10-15 years. Sea level was stable for the past five to six thousand years, indicating that these ice sheets were in near mass balance. Now, however, both Greenland and West Antarctica are shedding ice at accelerating rates. This is strong evidence that today's global temperature has reached a level higher than prior Holocene temperatures.

The conclusion is that global warming of 1°C relative to 1880-1920 mean temperature (i.e., 0.75°C above the 1951-1980 temperature or 0.3°C above the 5-year running mean

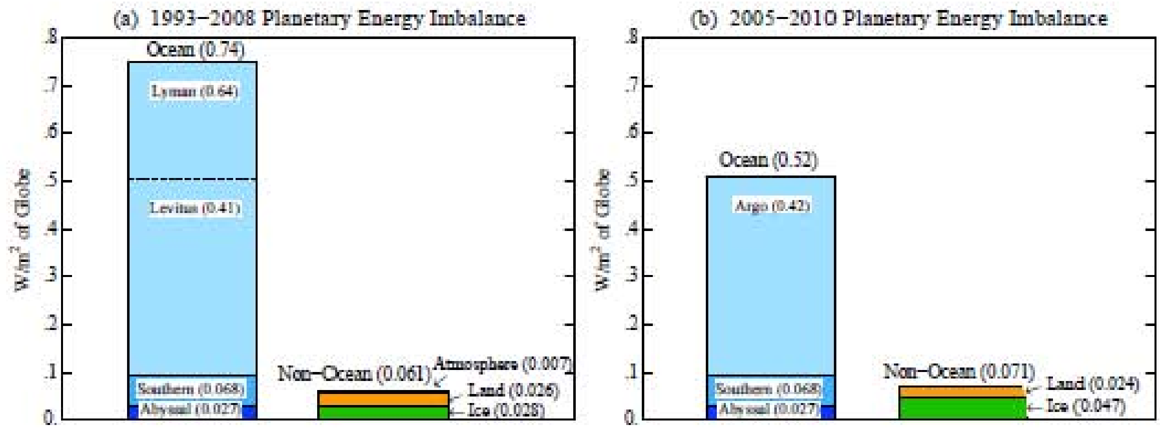

Figure 3. (a) Estimated planetary energy imbalance in 1993-2008, and (b) in 2005-2010. Data sources are given by Hansen et al. (2011).

temperature in 2000), if maintained for long, is already close to or into the 'dangerous' zone. The suggestion that 2°C global warming may be a 'safe' target is extremely unwise based on critical evidence accumulated over the past three decades. Global warming of this amount would be putting Earth on a path toward Pliocene-like conditions, i.e., a very different world marked by massive and continual disruptions to both society and ecosystems. It would be a world in which the world's species and ecosystems will have had no recent evolutionary experience, surely with consequences and disruptions to the ecosystem services that maintain human communities today. There are no credible arguments that such rapid would not have catastrophic circumstances for human well-being.

3. Earth's Energy Imbalance

Earth's energy balance is the ultimate measure of the status of Earth's climate. In a period of climate stability, Earth radiates the same amount of energy to space that it absorbs from incident sunlight. Today it is anticipated that Earth is out of balance because of increasing atmospheric CO_2. Greenhouse gases such as CO_2 reduce Earth's heat radiation to space, thus causing a temporary energy imbalance, more energy coming in than going out. This imbalance causes Earth to warm until energy balance is restored.

The immediate planetary energy imbalance due to an increase of CO_2 can be calculated precisely. It does not require a climate model. The radiation physics is rigorously understood. However, the current planetary energy imbalance is complicated by the fact that increasing CO_2 is only one of the factors affecting Earth's energy balance, and Earth has already partly responded to the net climate forcing by warming 0.8°C in the past century.

Thus authoritative determination of the state of the climate system requires measuring the planet's current energy imbalance. This is a technical challenge, because the magnitude of the imbalance is expected to be only about 1 W/m^2 or less, so measurements must have an accuracy that approaches 0.1 W/m^2. The most promising approach to achieve this accuracy is to measure ongoing changes of the heat content of the ocean, atmosphere, land, and ice on the planet.

The vast global ocean is the primary reservoir for changes of Earth's heat content. Because of the importance of this measurement, nations of the world launched a cooperative Argo float program, which has distributed more than 3000 floats around the world ocean

(Roemmich and Gilson, 2009). Each float repeatedly yoyos an instrument package to a depth of two kilometers and satellite-communicates the data to shore.

The Argo program did not attain planned distribution of floats until late 2007, but coverage reached 90% by 2005, allowing good accuracy provided that systematic measurement errors are kept sufficiently small. Prior experience showed how difficult it is to eliminate all measurement biases, but the exposure of the difficulties over the past decade leads to expectation that the data for the 6-year period 2005-2010 are the most precise achieved so far. The estimated standard error for that period, necessarily partly subjective, is 0.15 W/m^2.[9]

Smaller contributions to the planetary energy imbalance, from changes in the heat content of the land, ice and atmosphere, are also know more accurately in recent years. A key improvement during the past decade has been provided by the GRACE satellite that measures Earth's gravitational field with a precision that allows the rate of ice loss by Greenland and Antarctica to be monitored accurately.

Figure 3 summarizes the results of analyses of Earth's energy imbalance averaged over the periods 1993-2008 and 2005-2010. In the period 1993-2008 the planetary energy imbalance ranges from 0.57 W/m^2 to 0.80 W/m^2 among different analyses, with the lower value based on upper ocean heat content analysis of Levitus et al. (2009) and the higher value based on Lyman et al. (2010). For the period 2005-2010 the upper ocean heat content change is based on analysis of the Argo data by von Schuckmann and Le Traon (2011), which yields a planetary energy imbalance of 0.59 ± 0.15 W/m^2 (Hansen et al., 2011).

The energy imbalance in 2005-2010 is particularly important, because that period coincides with the lowest level of solar irradiance in the period since satellites began measuring the brightness of the sun in the late 1970s. Changes of solar irradiance are often hypothesized as being the one natural climate forcing with the potential to compete with human-made climate forcings, so measurements during the strongest solar minimum on record provide a conclusive evaluation of the sun's potential to reduce the planet's energy imbalance.

The conclusion is that Earth is out of energy balance by at least ~0.5 W/m^2. Our measured 0.59 W/m^2 for 2005-2010 suggests that the average imbalance over the 11-year solar cycle may be closer to 0.75 W/m^2.

This planetary energy imbalance is substantial, with implications for future climate change. It means that global warming will continue on decadal time scales, as the 0.8°C global warming so far is the response to only about half of the net human-made climate forcing.

Knowledge of Earth's energy imbalance allows us to specify accurately how much CO_2 must be reduced to restore energy balance and stabilize climate. CO_2 must be reduced from the current level of 390 ppm to 360 ppm to increase Earth's heat radiation to space by 0.5 W/m^2, or to 345 ppm to increase heat radiation to space by 0.75 W/m^2, thus restoring Earth's energy balance and stabilizing climate.

Earth's energy imbalance thus provides accurate affirmation of a conclusion reached earlier (Hansen et al., 2008), that the appropriate initial target level of atmospheric CO_2 to stabilize climate is "<350 ppm". This target level may need to be adjusted as it is approached, but, considering the time required to achieve a reversal of atmospheric CO_2 growth, more precise knowledge of the ultimate target for CO_2 will be available by the time CO_2 has been restored to a level approaching 350 ppm.

[9] Barker et al. (2011) describe a remaining bias due to sensor drift in pressure measurements. That bias is reduced in the analysis of von Schuckmann and Le Traon by excluding data from floats on a pressure-bias black list and data from profiles that fail climatology checks, but errors remain and require further analysis.

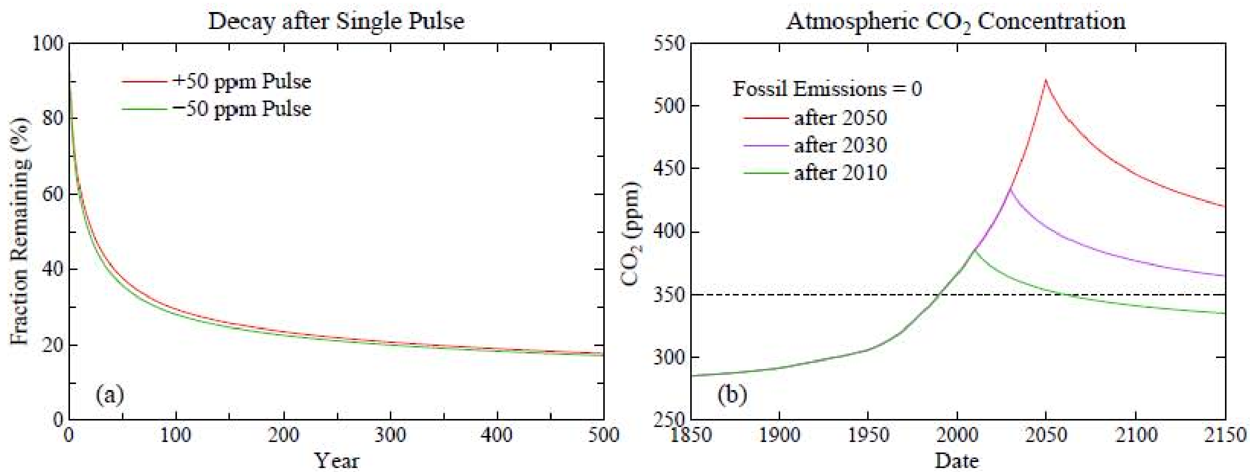

Figure 4. (a) Decay of instantaneous (pulse) injection and extraction of atmospheric CO_2, (b) atmospheric CO_2 if fossil fuel emissions terminated at end of 2011, 2030, 2050.

One reason that more precise specification than "<350 ppm" is inadvisable now is the uncertainty about the net effect of changes of other human-made climate forcings such as methane, other trace gases, reflecting aerosols, black soot, and the surface reflectivity. These forcings are smaller than that by CO_2, but not negligible.

However, the important point is that CO_2 is the dominant climate forcing agent and it will be all the more so in the future. The CO_2 injected into the climate system by burning fossil fuels will continue to affect our climate for millennia. We cannot burn all of the fossil fuels without producing a different planet, with changes occurring with a rapidity that will make Earth far less hospitable for young people, future generations, and most other species.

4. Carbon Cycle and Atmospheric CO_2

The 'carbon cycle' that defines the fate of fossil fuel carbon injected into the climate system is well understood. This knowledge allows accurate estimation of the amount of fossil fuels that can be burned consistent with stabilization of climate this century.

Atmospheric CO_2 is already about 390 ppm. Is it possible to return to 350 ppm or less within this century? Yes. Atmospheric CO_2 would decrease if we phased out fossil fuels. The CO_2 injected into the air by burning fossil fuels becomes distributed, over years, decades, and centuries, among the surface carbon reservoirs: the atmosphere, ocean, soil, and biosphere.

Carbon cycle models simulate how the CO_2 injected into the atmosphere becomes distributed among the carbon reservoirs. We use the well-tested Bern carbon cycle model (Joos et al., 1996)[10] to illustrate how rapidly atmospheric CO_2 can decrease.

Figure 4 (a) shows the decay of a pulse of CO_2 injected into the air. The atmospheric amount is reduced by half in about 25 years. However, after 500 years about one-fifth of the CO_2 is still in the atmosphere. Eventually, via weathering of rocks, this excess CO_2 will be deposited on the ocean floor as carbonate sediments. However, that process requires millennia.

It is informative, for later policy considerations, to note that a negative CO_2 pulse decays at about the same rate as positive pulse. Thus if we decide to suck CO_2 from the air, taking CO_2

[10] Specifically, we use the dynamic-sink pulse-response function representation of the Bern carbon cycle model (Joos et al., 1996), as described by Kharecha and Hansen (2008) and Hansen et al. (2008).

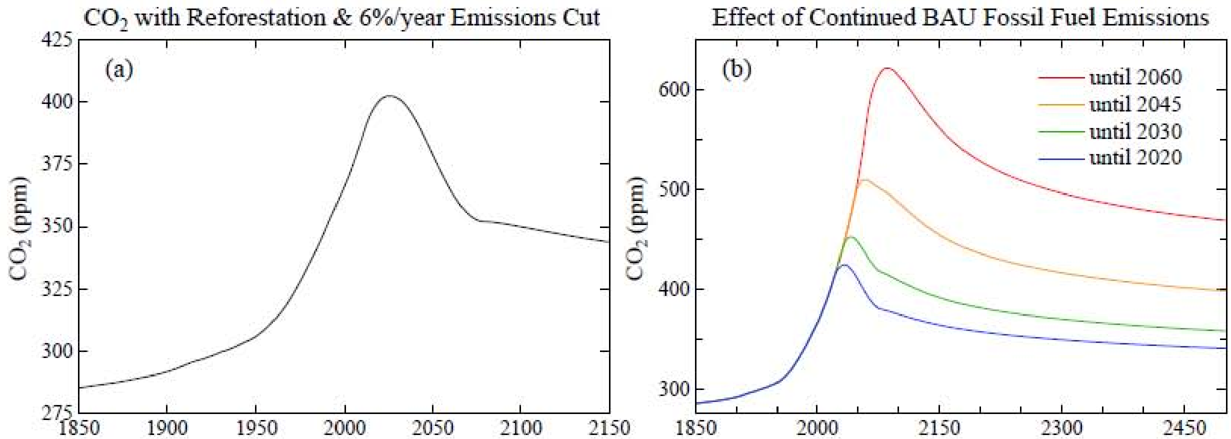

Figure 5. (a) Atmospheric CO_2 if fossil fuel emissions are cut 6% per year beginning in 2012 and 100 GtC reforestation drawdown occurs in the 2031-2080 period, (b) Atmospheric CO_2 with BAU emission increases until 2020, 2030, 2045, and 2060, followed by 5% per year emission reductions.

out of the carbon cycle, for example by storing it in carbonate bricks, the magnitude of the CO_2 change will decline as the negative increment becomes spread among the carbon reservoirs.

It is also informative to examine how fast atmospheric CO_2 would decline if fossil fuel use were halted today, or in 20 years, or in 40 years. Results are shown in Figure 4 (b). If emissions were halted in 2011, CO_2 would decline to 350 ppm at mid-century. With a 20 year delay in halting emissions, CO_2 returns to 350 ppm at about 2250. With a 40 year delay, CO_2 does not return to 350 ppm until after year 3000.

The scenarios in Figure 4 (b) assume that emissions continue to increase at the 'business-as-usual' (BAU) rate of the past decade (increasing by just over 2% per year) until they are suddenly halted. The results are indicative of how difficult it will be to get back to 350 ppm, if fossil fuel emissions continue to accelerate.

Do these results imply that it is implausible to get back to 350 ppm in a way that is essentially 'natural', i.e., in a way other than a 'geo-engineering' approach that sucks CO_2 from the air? Not necessarily. There is one other major factor, in addition to fossil fuel use, that affects atmospheric CO_2 amount: deforestation/reforestation.

Fossil fuel emissions account for about 80 percent of the increase of atmospheric CO_2 from 275 ppm in the preindustrial atmosphere to 390 ppm today. The other 20 percent is from net deforestation (here net deforestation accounts for any forest regrowth in that period). We take net deforestation over the industrial era to be about 100 GtC (gigatons of carbon), with an uncertainty of at least 50 percent (Stocker et al., 2011)[11].

There is considerable potential for extracting CO_2 from the atmosphere via reforestation and improved forestry and agricultural practices. The largest practical extraction is probably about 100 GtC (IPCC, 2001), i.e., equivalent to restoration of deforested land. Although complete restoration might appear to be unrealistic, 100 GtC uptake is probably feasible, because the human-enhanced atmospheric CO_2 level leads to an increase of carbon uptake by vegetation and soils. Competing uses for land – primarily expansion of agriculture to supply a growing world population – could complicate reforestation efforts. A decrease in the use of animal

[11] Net historical deforestation of 100 GtC and historical fossil fuel use yield good agreement with historical growth of atmospheric CO_2 (Figure S16 of Hansen et al., 2008), based on simulations with the Bern carbon cycle model.

products would substantially decrease the demand for agricultural land, as more than half of all crops are currently fed to livestock (Stehfest et al., 2009; UNEP, 2010).

We assume global reforestation (biospheric C uptake) of 100 GtC in our reforestation scenarios, with this obtained via a sinusoidal drawdown over the period 2031-2080. Alternative timings for this reforestation drawdown of CO_2 would have no qualitative effect on our conclusions about the potential for achieving a given CO_2 level such as 350 ppm.

Figure 5 (a) shows that 100 GtC reforestation results in atmospheric CO_2 declining to 350 ppm by the end of this century, provided that fossil fuel emissions decline by 6% per year beginning in 2013. Figure 5 (b) shows the effect of continued BAU fossil fuel emission (just over 2% per year) until 2020, 2030, 2045 and 2060 with 100 GtC reforestation in 2031-2080.

The scenario with emission cuts beginning in 2020 has atmospheric CO_2 return to 350 ppm at about 2300. If the initiation of emissions reduction is delayed to 2030 or later, then atmospheric CO_2 does not return to the 350 ppm level even by 2500.

The conclusion is that a major reforestation program does permit the possibility of returning CO_2 to the 350 ppm level within this century, but only if fossil fuel emission reductions begin promptly.

What about artificially drawing down atmospheric CO_2? Some people may argue that, given the practical difficulty of overcoming fossil fuel lobbyists and persuading governments to move rapidly toward post-fossil-fuel clean energy economies, 'geo-engineering' is the only hope. At present there are no large-scale technologies for air capture of CO_2, but it has been suggested that with strong research and development support and industrial scale pilot projects sustained over decades, it may be possible to achieve costs of about ~$200/tC (Keith et al., 2006).

At this rate, the cost of removing 50 ppm[12] of CO_2 is ~$20 trillion. However, as shown by Figure 4 (a), the resulting atmospheric CO_2 reduction is only ~15 ppm after 100 years, because most of the extraction will have leaked into other surface carbon reservoirs. The cost of CO_2 extraction needed to maintain a 50 ppm reduction on the century time scale is thus better estimated as ~$60 trillion.

In section 7 we note the economic and social benefits of rapidly phasing over to clean energies and increased energy efficiency, as opposed to continued and expanded extraction of fossil fuels. For the moment, we simply note that the present generation will be passing the CO_2 clean-up costs on to today's young people and future generations.

[12] The conversion factor to convert atmospheric CO_2 in ppm to GtC is 1 ppm ~ 2.12 GtC.

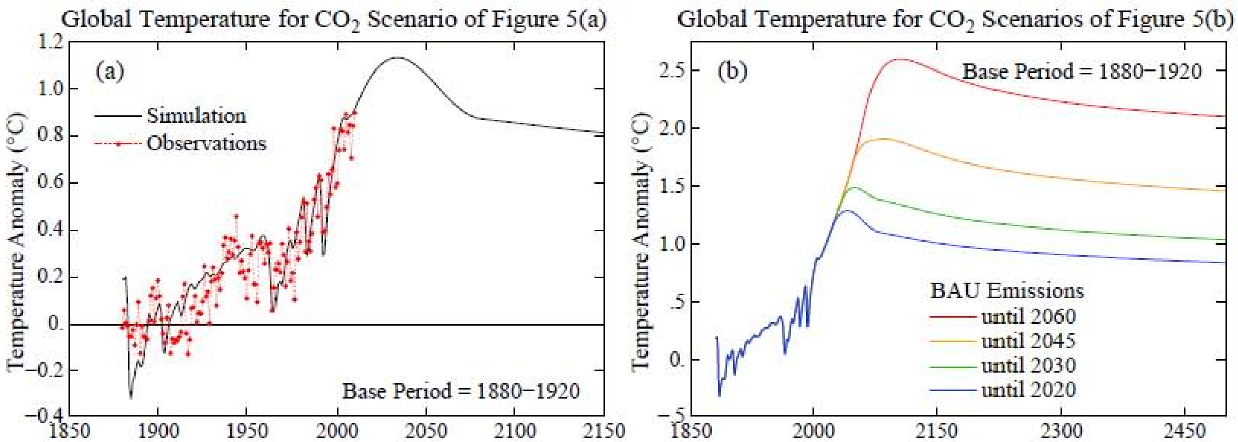

Figure 6. Simulated future global temperature for the CO_2 scenarios of Figure 5. Observed temperature record is from Hansen et al. (2010). Temperature is relative to the 1880-1920 mean. Subtract 0.26°C to use 1951-1980 as zero-point. Subtract 0.70°C to use 5-year running mean in 2000 as zero point.

5. Future Global Temperature Change

Future global temperature change will depend primarily upon atmospheric CO_2 amount. Although other greenhouse gases, such as methane and chlorofluorocarbons, contributed almost as much as CO_2 to the total human-caused climate forcings over the past century, CO_2 now accounts for more than 80 percent of the growth of greenhouse gas climate forcing (over the past 15 years). Natural climate forcings, such as changes of solar irradiance and volcanic aerosols, can cause global temperature variations, but their effect on the long-term global temperature trend is small compared with the effect of CO_2.

A simple climate response function can provide a realistic estimate of expected global temperature change for a given scenario of future atmospheric CO_2. Indeed, Hansen et al. (2011) show that such a function accurately replicates the results from sophisticated global climate models. In the simulations here we use the 'intermediate' response function of Hansen et al. (2011), which accurately replicates observed ocean heat uptake and observed temperature change over the past century, and we assume that the net change of other human-made climate forcings is small in comparison with the effect of CO_2.

One important caveat must be stressed. These calculations, as with most global climate models, incorporate only the effect of the so-called 'fast feedbacks' in the climate system, such as water vapor, clouds, aerosols, and sea ice. Slow feedbacks, such as ice sheet disintegration and climate-induced changes of greenhouse gases, as may occur with the melting of tundra and warming of continental shelves, are not included.

Exclusion of slow feedbacks is appropriate for the past century, because we know the ice sheets were stable and our climate simulations employ observed greenhouse gas amounts. The observed greenhouse gas amount includes any contribution from slow feedbacks. Exclusion of slow feedbacks in the 21st century is a dubious assumption, used in our illustrative computations only because the rate at which slow feedbacks come into play is poorly understood. However, we must bear in mind the potential for slow feedbacks to fundamentally alter the nature of future climate change, specifically the possibility of creating a situation in which continued climate change is largely out of humanity's control.

Slow feedbacks are thus one important consideration that helps to crystallize the need to keep maximum warming from significantly exceeding 1°C. With the current global warming of

~0.8°C evidence of slow feedbacks is beginning to appear, e.g., melting of tundra with release of methane (Walter et al., 2006), submarine methane release from dissociation of sea-bed gas hydrates in association with sea water temperature increase (Westbrook et al., 2009), and increasing ice mass loss from Greenland and Antarctica (Velicogna, 2009). The fact that observed effects so far are small suggests that these feedbacks may not be a major factor if maximum global warming is only ~1°C and then recedes.

On the other hand, if BAU CO_2 emissions continue for many decades there is little doubt that these slow feedbacks will come into play in major ways. Because the CO_2 injected into the air stays in the surface carbon reservoirs for millennia, the slow feedbacks surely will occur. It is only a question of how fast they will come into play, and thus which generations will suffer the greatest consequences.

There is thus strong indication that we face a dichotomy. Either we achieve a scenario with declining global CO_2 emissions, thus preserving a planetary climate resembling that of the Holocene or we set in motion a dynamic transition to a very different planet.

Can we define the level of global warming that would necessarily push us into such a dynamic transition? Given present understanding of slow feedbacks, we cannot be precise. However, consider the case in Figure 6 in which BAU emissions continue to 2030. In that case, even though CO_2 emissions are phased out rapidly (5% per year emission reductions) after 2030 and 100 GtC reforestation occurs in 2031-2080, the (fast-feedback) human-caused global temperature rise reaches 1.5°C and stays above 1°C until after 2500. It is highly unlikely that the major ice sheets could remain stable at their present size with such long-lasting warmth. Even if BAU is continued only until 2020, the temperature rise exceeds 1°C for about 100 years.

In contrast to scenarios with continued BAU emissions, Figure 6 (a) shows the scenario with 6% per year decrease of fossil fuel CO_2 emissions and 100 GtC reforestation in the period 2031-2080. This scenario yields additional global warming of ~0.3°C. Global temperature relative to the 1880-1920 mean would barely exceed 1°C and would remain above 1°C for only about 3 decades. Thus this scenario provides the prospect that young people, future generations, and other life on the planet would have a chance of residing in a world similar to the one in which civilization developed.

The precise consequences if BAU emissions continue several decades are difficult to define, because such rapid growth of climate forcing would take the world into uncharted territory. Earth has experienced a huge range of climate states during its history, but there has never been such a large rapid increase of climate forcings as would occur with burning of most fossil fuels this century. The closest analogy in Earth's history is probably the PETM (Paleocene-Eocene Thermal Maximum) in which rapid global warming of at least 5°C occurred (Zachos et al., 2001), probably as a consequence of melting methane hydrates (Zeebe et al., 2009). The PETM is instructive because it occurred during a 10-million year period of global warming, and thus the methane release was probably a feedback effect magnifying the warming.

Global warming that occurred over the period from 60 Mya (million years ago) to 50 Mya can be confidently ascribed to increasing atmospheric CO_2. That was the period in which the Indian subcontinent was moving rapidly through the Indian Ocean, just prior to its collision with Asia, when it began to push up the Himalayan Mountains and Tibetan Plateau. Continental drift over carbonate-rich ocean crust is the principal source of CO_2 from the solid Earth to the surface reservoirs of carbon.[13]

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[13] The principal sink of CO_2, i.e., the mechanism that returns carbon to the solid Earth on long time scales, is the weathering process. Chemical reactions associated with weathering of rocks results in rivers carrying carbonate sediments that are deposited on the ocean floor.

The global warming between 60 Mya and 50 Mya was about 5°C, thus at a rate less than 1°C per million years. Approximately 55 Mya there was, by paleoclimae standards, a very rapid release of 3000-5000 GtC into the surface climate system, presumably from melting of methane hydrates based on the absence of any other known source of that magnitude. This injection of carbon and rapid additional warming of about 5°C occurred over a period of about 10,000 years, with most of the carbon injection during two 1-2 thousand year intervals. The PETM witnessed the extinction of almost half of the deep ocean foraminifera (microscopic shelled animals, which serve as a biological indicator for ocean life in general), but, unlike several other large warming events in Earth's history, there was little extinction of land plants and animals.

The important point is that the rapid PETM carbon injection was comparable to what will occur if humanity burns most of the fossil fuels, but the PETM occurred over a period that was 10-100 times longer. The ability of life on Earth today to sustain a climate shock comparable to the PETM but occurring 10-100 times faster is highly problematic, at best. Climate zones would be shifting at a speed far faster than species have ever faced. Thus if humanity continues to burn most of the fossil fuels, Earth, and all of the species residing on it, will be pushed into uncharted climate change territory, with consequences that are practically impossible to foresee.

6. Consequences of Continued Global Warming

The unparalleled rapidity of the human-made increase of global climate forcing implies that there are no close paleoclimate analogies to the current situation. However, the combination of paleoclimate data and observations of ongoing climate change provide useful insight.

Paleoclimate data serve mainly as an indication of likely long-term responses to changed boundary conditions. Observations of ongoing climate change provide information relevant to the rate at which changes may occur.

Yet we must bear in mind that some important processes, such as ice sheet disintegration and species extermination, have the potential to be highly non-linear. That means changes can be slow until a tipping point is reached (Lenton et al., 2008) at which more rapid change occurs.

Sea level. If all or most of the fossil fuels are burned global warming will be at least several degrees Celsius. The eventual sea level change in response to the global warming will be many meters and global coast lines will be transfigured. However, we do not know how rapidly ice sheets can disintegrate, because Earth has never experienced such rapid global warming.

During the most recent prior interglacial period, the Eemian, global mean temperature was at most of the order of 1°C warmer than the Holocene (Figure 2). During the Eemian sea level averaged 4-6 meters higher than today, there were several instances of sea level change by 1-2 meters per century, and sea level reached a peak level about 8 meters higher than today (Hearty and Neumann, 2001; Rohling et al., 2008; Kopp et al, 2009; Muhs et al., 2011). During the Pliocene, when global mean temperature may have been 2°C warmer than the Holocene (Figure 2), sea level was probably 15-25 meters higher than today (Dowsett et al., 1999, 2009; Naish et al., 2009).

Expected sea level rise due to human-caused climate change has been controversial partly because the discussion and the predictions of IPCC (2001, 2007) have focused on sea level rise at a specific date, 2100. Recent estimates of likely sea level rise by 2100 are of the order of 1 m (Vermeer and Rahmstorf, 2009; Grinsted et al., 2010). Ice-dynamics studies estimate that rates of sea-level rise of 0.8 to 2 m per century are feasible (Pfeffer et al., 2008) and Antarctica alone may contribute up to 1.5 m per century (Turner et al., 2009). Hansen (2005, 2007) has argued that BAU CO_2 emissions produce a climate forcing so much larger than any experienced in prior interglacial periods that a non-linear ice sheet response with multi-meter sea level rise may occur this century.

The best warning of an imminent period of sustained nonlinear ice sheet loss will be provided by accurate measurements of ice sheet mass. The GRACE satellite, which has been measuring Earth's gravitational field since 2003 reveals that the Greenland ice sheet is losing mass at an accelerating rate, now more than 200 cubic kilometers per year, and Antarctica is losing more than 100 cubic kilometers per year (Sorensen and Forsberg, 2010; Rignot et al., 2011). However, the present rate of sea level rise, 3 cm per decade, is moderate, and the ice sheet mass balance record is too short to determine whether we have entered a period of continually accelerating ice loss.

Satellite observations of Greenland show that the surface area with summer melting has increased over the period of record, which extends back to the late 1970s (Steffen et al., 2004; Tedesco et al., 2011). Yet the destabilizing mechanism of greatest concern is melting of ice shelves, tongues of ice that extend from the ice sheets into the oceans and buttress the ice sheets, limiting the rate of discharge of ice to the ocean. Ocean warming is causing shrinkage of ice shelves around Greenland and Antarctica (Rignot and Jacobs, 2002).

Loss of ice shelves can open a pathway to the ocean for portions of the ice sheets that rest on bedrock below sea level. Most of the West Antarctic ice sheet, which alone could raise sea level by 6 meters, is on bedrock below sea level, so it is the ice sheet most vulnerable to rapid change. However, parts of the larger East Antarctic ice sheet are also vulnerable. Indeed, satellite gravity and radar altimetry reveal that the Totten Glacier of East Antarctica, fronting a large ice mass grounded below sea level, is already beginning to lose mass (Rignot et al., 2008)

The important point is that uncertainties about sea level rise mainly concern the timing of large sea level rise if BAU emissions continue, not whether it will occur. If all or most fossil fuels are burned, the carbon will be in the climate system for many centuries, in which case multi-meter sea level rise should be expected (e.g., Rohling et al., 2009).

Children born today can expect to live most of this century. If BAU emissions continue, will they suffer large sea level rise, or will it be their children, or their grandchildren?

Shifting climate zones. Theory and climate models indicate that subtropical regions will expand poleward with global warming (Held and Soden, 2006; IPCC, 2007). Observations reveal that a 4-degree latitudinal shift has occurred already on average (Seidel and Randel, 2006), yielding increased aridity in southern United States (Barnett et al., 2008; Levi, 2008), the Mediterranean region, and Australia. Increased aridity and temperatures have contributed to increased forest fires that burn hotter and are more destructive in all of these regions (Westerling et al., 2006).

Although there is large year-to-year variability of seasonal temperature, decadal averages reveal that isotherms (lines of a given average temperature) having been moving poleward at a rate of about 50 km per decade during the past three decades (Hansen et al., 2006). This rate of shifting of climatic zones exceeds natural rates of change. The direction of movement has been monotonic (poleward) since about 1975. As long as the planet is as far out of energy balance as at present, that trend necessarily will continue, a conclusion based on comparison of the observed trend with interdecadal variability in climate simulations (Hansen et al., 2007).

Humans may be better able to adapt to shifting of climate zones, compared with many other species. However, political borders can interfere with migration, and indigenous ways of life may be adversely affected. Impacts are apparent in the Arctic, with melting tundra, reduced sea ice, and increased shoreline erosion. Effects of shifting climate zones may also be important for native Americans who possess specific designated land areas, as well as other cultures with long-standing traditions in South America, Africa, Asia and Australia.

Loss of Species. Explosion of the human population and its presence on the landscape in the past few centuries is having a profound influence on the well being of all the other species. As recently as two decades ago biologists were more concerned with effects on biodiversity other than climate change, such as land use changes, nitrogen fertilization, and direct effects of increased atmospheric CO_2 on plant ecophysiology (Parmesan, 2006). However, easily discernible impacts on animals, plants, and insects of the nearly monotonic global warming during the past three decades (Figure 1) has sharply altered perceptions of the greatest threats.

A dramatic awakening was provided by sudden widespread decline of frogs, with extinction of entire mountain-restricted species attributed to global warming (Pounds et al., 1999, 2006). Pounds et al. (2006) attribute the amphibian declines principally to the fact that climate change encouraged outbreaks of deleterious fungi. Although there are somewhat different interpretations of detailed processes involved in the amphibian declines and extinctions (Alford et al., 2007; Fagotti and Pascolini, 2007), there is agreement that global warming is a main contributor to a global amphibian crisis: "The losses portent a planetary-scale mass extinction in the making. Unless humanity takes immediate action to stabilize the climate, while also fighting biodiversity's other threats, a multitude of species is likely to vanish" (Pounds et al., 2007).

Mountain-restricted species in general are particularly vulnerable to global warming. As warming causes isotherms to move up the mountainside so does the specific climate zone in which a given specific species can survive. If global warming continues unabated, i.e., if all fossil fuels are burned, many mountain-dwelling species will be driven to extinction.

The same is true for species living in polar regions. There is documented evidence of reductions in the population and health of Arctic species living in the southern parts of the Arctic and Antarctic species in the more northern parts of the Antarctic.

A critical factor for survival of some Arctic species will be retention of all-year sea ice. Continued BAU fossil fuel use will result in loss of all Arctic summer sea ice within the next several decades. In contrast, the scenario in Figure 5a, with global warming peaking just over 1°C and then declining slowly, should allow some summer sea ice to survive and then gradually increase to levels representative of recent decades.

The threat to species survival is not limited to mountain and polar species. Plant and animal distributions are a reflection of the regional climates to which they are adapted. Although species attempt to migrate in response to climate change, their paths may be blocked by human-constructed obstacles or natural barriers such as coast lines. As the shift of climate zones becomes comparable to the range of some species, the less mobile species will be driven to extinction. Because of extensive species interdependencies, this can lead to mass extinctions.

Mass extinctions have occurred in conjunction with rapid climate change during Earth's long history, and new species evolved over hundreds of thousands and millions of years. But such time scales are almost beyond human comprehension. If we drive many species to extinction we will leave a more desolate planet for our children, grandchildren, and as many generations as we can imagine.

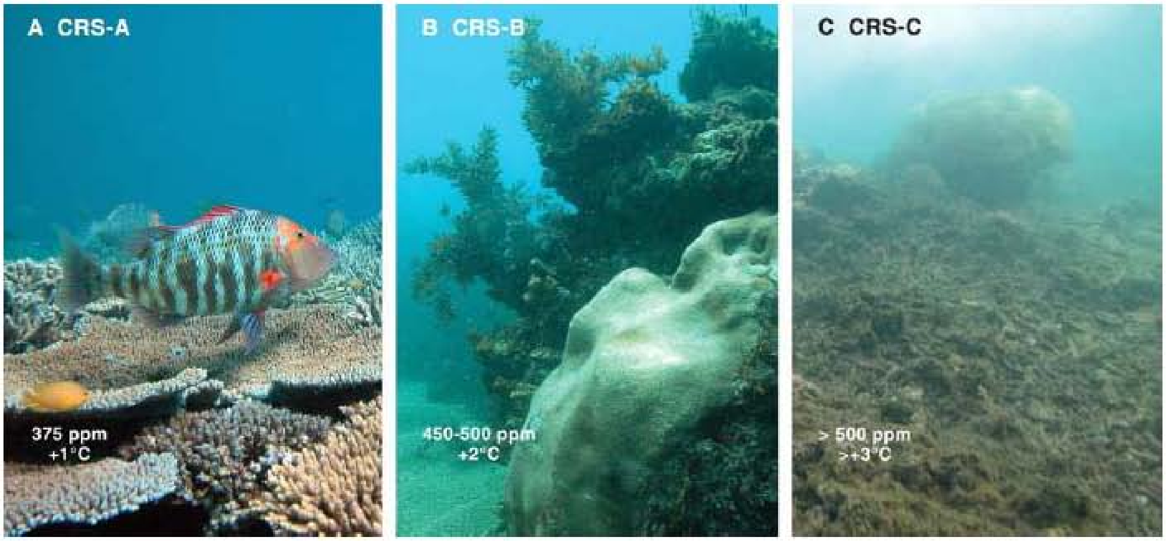

Figure 7. Extant reefs used as analogs (Hoegh-Guldberg et al., 2007) for ecological structures anticipated for scenarios A (375 ppm CO_2, +1°C), B (450-500 ppm CO_2, +2°C), C (>500 ppm CO_2, >+3°C)

Coral reef ecosystems. Coral reef ecosystems are the most biologically diverse marine ecosystem, often described as the rainforests of the ocean. An estimated 1-9 million species (most of which have not yet been described; Reaka-Kudla 1997) populate coral reef ecosystems generating ecosystem services that are crucial to the well-being of at least 500 million people that populate tropical coastal areas. These coral reef ecosystems are vulnerable to current and future warming and acidification of tropical oceans. Acidification arises due to the production of carbonic acid as increasing amounts of CO_2 enter the world's oceans. Comparison of current changes with those seen in the palaeontological record indicate that ocean pH is already outside where it has been for several million years (Raven et al. 2005; Pelejero et al. 2010).

Mass coral bleaching and a slowing of coral calcification are already disrupting coral reef ecosystem health (Hoegh-Guldberg et al 2007; De'Ath et al. 2009). The decreased viability of reef-building corals have led to mass mortalities, increasing coral disease, and slowing of reef carbonate accretion. Together with more local stressors, the impacts of global climate change and ocean acidification are driving a rapid contraction (1-2% per year, Bruno and Selig 2007) in the extent of coral reef ecosystems.

Figure 7 shows extant reefs that are analogs for ecological structures anticipated by Hoegh-Guldberg et al. (2007) to be representative of ocean warming and acidification expected to accompany CO_2 levels of 375 ppm with +1°C, 450-500 ppm with +2°C, and >500 ppm with > +3°C. Loss of the three-dimensional framework that typifies coral reefs today has consequences for the millions of species that depend on this coral reef framework for their existence. The loss of these three-dimensional frameworks also has consequences for other important roles coral reefs play in supporting fisheries and protecting coastlines from wave stress. The consequences of losing coral reefs are likely to be substantial and economically devastating for multiple nations across the planet when combined with other impacts such as sea level rise.

The situation with coral reefs is summarized by Schuttenberg and Hoegh-Guldberg (2007) thus: "Although the current greenhouse trajectory is disastrous for coral reefs and the millions of people who depend on them for survival, we should not be lulled into accepting a world without corals. Only by imagining a world with corals will we build the resolve to solve the challenges ahead. We must avoid the "game over" syndrome and marshal the financial, political, and technical resources to stabilize the climate and implement effective reef management with unprecedented urgency."

Hydrologic extremes and storms. The extremes of the hydrologic cycle are intensified as Earth becomes warmer. A warmer atmosphere holds more moisture, so heavy rains become more intense and increase flooding. Higher temperatures, on the other hand, cause an intensification of droughts, as does expansion of the subtropics with global warming. The most recent IPCC (2007) report confirms existence of expected trends, e.g., precipitation has generally increased over land north of 30°N and decreased in more tropical latitudes. Heavy precipitation events have increased substantially. Droughts are more common, especially in the tropics and subtropics. Tropospheric water vapor has increased.

Mountain glaciers. Mountain glaciers are in near-global retreat (IPCC, 2007). After a one-time added flush of fresh water, glacier demise will yield summers and autumns of frequently dry rivers originating in the Himalayas, Andes, and Rocky Mountains (Barnett et al., 2008) that now supply water to hundreds of millions of people. Present glacier retreat, and warming in the pipeline, indicate that 390 ppm of CO_2 is already a threat for future fresh water security.

Human health. Human health is affected by climate change in a large number of ways, principal ones summarized in Table 1 under the headings: (1) heat waves, (2) asthma and allergies, (3) infectious disease spread, (4) pests and disease spread across taxa: forests, crops and marine life, (5) winter weather anomalies, (6) drought, (7) food insecurity.

7. Societal Implications

The science is clear. Human-made climate forcing agents, principally CO_2 from burning of fossil fuels, have driven planet Earth out of energy balance – more energy coming in than going out. The human-made climate forcing agents are the principal cause of the global warming of 0.8°C in the past century, most of which occurred in the past few decades.

Earth's energy imbalance today is the fundamental quantity defining the state of the planet. With the completion of the near-global distribution of Argo floats and reduction of calibration problems, it is confirmed that the planet's energy imbalance averaged over several years, is at least 0.5 W/m^2. The imbalance averaged over the past solar cycle is probably closer to 0.75 W/m^2. An imbalance of this magnitude assures that continued global warming is in the pipeline, and thus so are increasing climate impacts.

Global climate effects are already apparent. Arctic warm season sea ice has decreased more than 30 percent over the past few decades. Mountain glaciers are receding rapidly all over the world. The Greenland and Antarctic ice sheets are shedding mass at an accelerating rate, already several hundred cubic kilometers per year. Climate zones are shifting poleward. The subtropics are expanding. Climate extremes are increasing. Summer heat of a degree that occurred only 2-3 percent of the time in the period 1950-1980, or, equivalently, in a typical summer covered 2-3 percent of the globe, now occurs over 20-40 percent of Earth's surface each summer (http://www.columbia.edu/~jeh1/mailings/2011/20110327_Perceptions.pdf). Within these expanded areas smaller regions of more extreme anomalies, such as the European heat wave of 2003 and the Moscow and Pakistan heat waves of 2010.

Global climate anomalies and climate impacts will continue to increase if fossil fuel use continues at current levels or increases. Earth's history provides our best measure of the ultimate climate response to a given level of climate forcing and global temperature change. Continuation of business-as-usual fossil fuel emissions for even a few decades would guarantee that global warming would pass well beyond the warmest interglacial periods in the past million

Table 1. Climate Change Impacts on Human Health	
Heatwaves.	Heatwaves are not only increasing in frequency, intensity and duration, but their nature is changing. Warmer nighttime temps [double the increase of average temperature since 1970 (Karl et al.)] and higher humidity (7% more for each 1ºC warming) that raises heat indices and make heat-waves all the more lethal.
Asthma and allergies.	Asthma prevalence has more than doubled in the U.S. since 1980 and several exacerbating factors stem from burning fossil fuels. Increased CO_2 and warming boost pollen production from fast growing trees in the spring and ragweed in the fall (the allergenic proteins also increase). Particulates help deliver pollen and mold spores deep into the lung sacs. Ground-level ozone primes the allergic response (and O_3 increases in heat-waves). Climate change has extended the allergy and asthma season two-four weeks in the Northern Hemisphere (depending on latitude) since 1970. Increased CO_2 stimulates growth of poison ivy and a chemical in it (uruschiol) that causes contact dermatitis.
Infectious disease spread.	The spread of infectious diseases is influenced by climate change in two ways: warming expands the geographic and temporal conditions conducive to transmission of vector-borne diseases (VBDs), while floods can leave "clusters" of mosquito-, water – and rodent-borne diseases (and spread toxins). With the ocean the repository for global warming and the atmosphere holding more water vapor, rain is increasing in intensity -- 7% overall in the US since 1970, 2"/day rains 14%, 4"/day rains 20%, and 6"/day rains 27% since 1970 (Groisman and Knight 2005), with multiple implications for health, crops and nutrition. Tick-borne Lyme disease (LD) is the most important VBD in the US. LD case reports rose 8-fold in New Hampshire in the past decade and 10-fold (and now include all of its 16 counties). Warmer winters and disproportionate warming toward the poles mean that the changes in range are occurring faster than models based on changes in average temperatures project. Biological responses of vectors (and plants) to warming are, in general, underestimated and may be seen as leading indicators of warming due to the disproportionate winter (Tminimum or Tmin) and high latitude warming.
Pests and disease spread across taxa: forests, crops and marine life.	Pests and diseases of forests, crops and marine life are favored in a warming world. Bark beetles are overwintering (absent sustained killing frosts) and expanding their range, and getting in more generations, while droughts in the West dry the resin that drowns the beetles as they try to drive through the bark. (Warming emboldens the pests while extremes weaken the hosts.) Forest health is also threatened in the Northeast U.S. (Asian Long-horned beetle and wooly adelgid of hemlock trees), setting the stage for increased wildfires with injury, death and air pollution, loss of carbon stores, and damage to oxygen and water supplies. In sum, forest pests threaten basic life support systems that underlie human health. Crop pests and diseases are also encouraged by warming and extremes. Warming increases their potential range, while floods foster fungal growth and droughts favor whiteflies, aphid and locust. Higher CO_2 also stimulates growth of agricultural weeds. More pesticides, herbicides and fungicides (where available) pose other threats to human health. Crop pests take up to 40% of yield annually, totaling ~$300 billion in losses (Pimentel) Marine diseases (e.g., coral, sea urchin die-offs, and others), harmful algal blooms (from excess nutrients, loss of filtering wetlands, warmer seas and extreme weather events that trigger HABs by flushing nutrients into estuaries and coastal waters), plus the over 350 "dead zones" globally affect fisheries, thus nutrition and health.
Winter weather anomalies.	Increasing winter weather anomalies is a trend to be monitored. More winter precipitation is falling as rain rather than snow in the NH, increasing the chances for ice storms, while greater atmospheric moisture increases the chances of heavy snowfalls. Both affect ambulatory health (orthopedics), motor vehicle accidents, cardiac disease and power outages with accompanying health effects.
Drought.	Droughts are increasing in frequency, intensity, duration, and geographic extent. Drought and water stress are major killers in developing nations, are associated with disease outbreaks (water-borne cholera, mosquito-borne dengue fever (mosquitoes breed in stored water containers)), and drought and higher CO2 increase the cyanide content of cassava, a staple food in Africa, leading to neurological disabilities and death.
Food insecurity.	Food insecurity is a major problem worldwide. Demand for meat, fuel prices, displacement of food crops with those grown for biofuels all contribute. But extreme weather events today are the acute driver. Russia's extensive 2010 summer heat-wave (over six standard deviations from the norm, killing over 50,000) reduced wheat production ~40%; Pakistan and Australian floods in 2010 also affected wheat and other grains; and drought in China and the US Southwest are boosting grain prices and causing shortages in many nations. Food riots are occurring in Uganda and Burkino Faso, and the food and fuel hikes may be contributing to the uprisings in North Africa and the Middle East. Food shortages and price hikes contribute to malnutrition that underlies much of poor health and vulnerability to infectious diseases. Food insecurity also leads to political instability, conflict and war.

years, implying transition to literally a different planet than the one that humanity has experienced. Today's young people and following generations would be faced with continuing climate change and climate impacts that would be out of their control.

Yet governments are taking no actions to substantially alter business-as-usual fossil fuel emissions. Rhetoric about a 'planet in peril' abounds. But actions speak louder than words. Continued investments in infrastructure to expand the scope and nature of fossil fuel extraction expose reality.

The matter is urgent. CO_2 injected into the atmosphere by burning fossil fuels remains in the surface climate system for millennia. The practicality of any scheme to extract CO_2 from the air is dubious. Potentially huge costs would be left to young people and future generations.

The apparent solution is to phase out fossil fuel emissions in favor of clean energies and energy efficiency. Governments have taken steps to promote renewable energies and encourage energy efficiency. But renewable energies total only a few percent of all energy sources, and improved efficiency only slows the growth of energy use. The transition to a post-fossil fuel world of clean energies is blocked by a fundamental fact, as certain as the law of gravity: as long as fossil fuels are the cheapest energy, they will be burned.

However, fossil fuels are cheapest only because they are subsidized directly and indirectly, and because they are not made to pay their costs to society – the costs of air and water pollution on human health and costs of present and future climate disruption and change.

Those people who prefer to continue business-as-usual assert that transition to fossil fuel alternatives would be economically harmful, and they implicitly assume that fossil fuel use can continue indefinitely. In reality, it will be necessary to move to clean energies eventually, and most economists believe that it would be economically beneficial to move in an orderly way to the post fossil fuel era via a steadily increasing price on carbon emissions.

A comprehensive assessment of the economics, the arguments for and against a rising carbon price, is provided in the book The Case for a Carbon Tax (Hsu, 2011). An across-the-board price on all fossil fuel CO_2 emissions emerges as the simplest, easiest, fastest and most effective way to phase down carbon emissions, and this approach presents fewer obstacles to international agreement.

The chief obstacles to a carbon price are often said to be the political difficulty, given the enormous resources that interest groups opposing it can bring to bear, and the difficulty of getting the public to understand arcane economic issues. On the other hand, a simple, transparent, gradually rising fee on carbon emissions collected, with the proceeds distributed to the public, can be described succinctly, as it has by Jim DiPeso, Policy Director of Republicans for Environmental Protection http://www.rep.org/opinions/weblog/weblog10-10-11.html

The basic matter, however, is not one of economics. It is a matter of morality – a matter of intergenerational justice. The blame, if we fail to stand up and demand a change of course, will fall on us, the current generation of adults. Our parents honestly did not know that their actions could harm future generations. We, the current generation, could only pretend that we did not know.

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ATTACHMENT B

John Meyer, Using the Public Trust Doctrine to Ensure the National Forests Protect the Public from Climate Change, 16 Hastings W.-Nw. J. Envtl. L. & Pol'y 195 (2010).

Using the Public Trust Doctrine to Ensure the National Forests Protect the Public from Climate Change

*John Meyer**

Logging is one of the major contributors to greenhouse gas emissions. Every unnecessary timber sale by the Forest Service contributes to our climate change crisis. While President Barack Obama has stated his intention to have science guide the decision-making process, he recently allocated half a billion dollars for logging projects under a statutory framework that lacks scientific grounding. After an introduction, the article will look at the Healthy Forests Restoration Act and the American Recovery and Reinvestment Act of 2009 - a framework that encourages the Forest Service to continue polluting our atmosphere. Part III will look at the historical statutes responsible for creating the agency's institutional memory - one that has either elevated timber harvesting above conservation measures, or afforded the agency the discretion necessary to make the choice. Part IV will survey the current statutory provisions applicable to the Forest Service to demonstrate why the agency refuses to pick up the ball on climate change. Part V will look at how the public trust doctrine can be used to require the agency to do its part in fighting global warming.

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I. Introduction

Our forests store a lot of the world's carbon, and Americans are responsible for protecting that capacity.

-Forest Service Chief Gail Kimbell[1]

The Forest Service manages public lands in our national forests and grasslands, which encompass 193 million acres.[2] The trees, plants, and soils in these forests and grasslands play a "critical role" in mitigating climate change by driving the global carbon cycle—sequestering carbon dioxide through photosynthesis and releasing it through respiration.[3] America's forests currently offset about ten percent of our country's carbon emissions,[4]

1. Gail Kimbell, U.S. Forest Service Chief, Forest Management and Climate Change Response, Address at the 8th National Conference on Science, Policy and the Environment (Jan. 16, 2008) [hereinafter "*Forest Management*"] (transcript available at http://www.fs.fed.us/news/2008/ speeches/01/climate.shtml).

2. U.S.D.A. Forest Service Home Page, www.fs.fed.us

3. Union of Concerned Scientists, *Recognizing Forests Role in Climate Change*,http://www.ucsusa.org/global_warming/solutions/forest_solutions/recognizing-forests-role-in.html (last visited Mar. 21, 2009).

4. ANN INGERSON, THE WILDERNESS SOCIETY, U.S. FOREST CARBON AND CLIMATE CHANGE: CONTROVERSIES AND WIN-WIN APPROACHES (2007); Gail Kimbell, U.S. Forest Service Chief, The Future of Forest Research in the United States, Address at IUFRO

but have the potential to sequester up to thirty-six percent of industrial emissions under different policy approaches.[5] More carbon is stored in forests than in anything else but oceans,[6] making the vast forest estates "globally important storehouses of carbon."[7]

Even though the use of fossil fuels is generally considered the primary contributor to the world's increase in atmospheric concentration of carbon dioxide,[8] science has documented how unnecessary logging by the Forest Service is contributing to climate change.[9] The agency's traditional approach to forest management needs to be rethought with the challenge of global climate change upon us all.[10]

Despite a statutory mandate to study how the national forests can mitigate climate change impacts,[11] the agency has largely failed to consider its own science that suggests many logging practices are scientifically unjustified,[12] thereby contributing to global warming.[13] Moreover, the bulk of environmental statutes governing land management were enacted decades ago and did not contemplate the disastrous climate change impacts the agency itself is predicting.[14] The statutes that are applicable do

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Conference: Forest Research Management in an Era of Globalization (Apr. 18, 2008) (hereinafter "*Forest Research*") (transcript available at http://www.fs.fed.us/news/2007/speeches/04/research.shtml).

5. INGERSON, *supra* note 4, at 2.

6. Kimbell, *Forest Management*, *supra* note 1.

7. *Id.*; Union of Concerned Scientists, *supra*, note 3.

8. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE ("IPCC"), WORKING GROUP I, CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS - SUMMARY FOR POLICYMAKERS (2007).

9. Chad Hanson, *Logging Industry Misleads on Climate and Forest Fires*, THE JOHN MUIR PROJECT OF EARTH ISLAND INSTITUTE ("[L]ogging is one of the major contributors to greenhouse gas emissions.") (citations omitted), *available at* http://www.johnmuirproject.org/pdf/OpEdClimateAndFireGeneralTextJune08.pdf.

10. *See* Dale Bosworth, Former Forest Service Chief, Climate Change and the Future of Forestry, Address at the North American Forest Commission (Oct. 23, 2006) (transcript available at http://www.fs.fed.us/news/2006/speeches/10/climate-change.shtml) ("The bottom line is this: As foresters, we need to start thinking long-term about the most serious problems we will face in the coming century, and climate change is certainly one of them. For years, we have been trying with mixed success to manage uncharacteristically severe wildfires and outbreaks of forest pests. Now, we are coming to see that climate change is part of the underlying problem - and a common thread.").

11. 16 U.S.C. § 1642(a)(2), (c)(1) (2006).

12. *See infra*, notes 40-41; 49-51; 56-57.

13. *See* Hanson, *supra* note 9.

14. Gail Kimbell, U.S. Forest Service Chief, Managing Forests in an Era of Climate Change: Perspectives from the U.S., Address at the Forest Service 2008 Adaptation Conference (Aug. 25, 2008) (hereinafter *Managing Forests*) (transcript available at http://www.fs.fed.us/news/2008/speeches/08/iufro.shtml) ("[C]limatic disruption will have disastrous consequences in many parts of the world.").

not require the agency to reduce its carbon footprint. A new science-based approach with specific, measurable, and enforceable standards is needed[15] if the Forest Service is going to help avert the extensive and catastrophic impacts that are predicted.[16]

Timber in National Forests is public property, managed by the Federal Government on behalf of present and future generations.[17] As trustee, the Forest Service must protect the basic value of the resource.[18] Accordingly, the government not only has the ability to protect the trees and the ecosystem services they provide, it has the obligation.[19] How the government manages our assets is subject to our supervision.[20]

The public trust doctrine can be used to require the agency to manage our forests in a way that protects us from the impacts of climate change. The idea of using the public trust doctrine to influence management of public resources is not new. Forests have been treated as a public resource in England and the doctrine has made past appearances in challenges to federal land management in the United States. As such, it is not far fetched to use the public trust doctrine to require the Forest Service to use the best available science when managing our national forests for protection against

15. Steven Ruddell, et al., *The Role for Sustainably Managed Forests in Climate Change Mitigation*, J. FORESTRY 315 (2007).

16. *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC), CLIMATE CHANGE 2001: SYNTHESIS REPORT SUMMARY FOR POLICYMAKERS 8-16 (2001) (describing the projected effects of climate change, including increased sea levels, increased threats to human health, changes in ecological productivity, and increases in extreme climate events); *see also* IPCC, CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS, SUMMARY FOR POLICYMAKERS 5 (2007), *available at* http://www.ipcc.ch/SPM2feb07.pdf (reporting that improved understanding of climate change has confirmed, with "a very high confidence," that human activities have increased greenhouse gas levels in the atmosphere since 1750, and this increase has had a warming effect on the earth); UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, CLIMATE CHANGE—SCIENCE, TEMPERATURE CHANGES, http://www.epa.gov/climatechange/science/ recenttc.html (last visited Nov. 18, 2007) (The eight warmest years on record (since 1850) have all occurred since 1998 and the trend is expected to continue).

17. *See Light v. United States*, 220 U.S. 523, 537 (1911) ("the public lands are held in trust for all the people of the United States"); *see also Arizona Ctr. For Law in the Pub. Interest v. Hassell*, 837 P.2d 158, 169 (Ariz Ct. App. 1991) ("The beneficiaries of the public trust are not just present generations but those to come.").

18. Knight v. United States Land Ass'n, 142 U.S. 161, 181 (1891) (stating that the federal government is the "guardian of the people of the United States over public lands."); Gerald Torres, *Who Owns The Sky?*, 19 PACE ENVTL. L. REV. 515, 519 (2002) ("the property is deemed not to belong to the state, but to the people for whom the state is beneficially managing the asset.").

19. Torres, *supra* note 18, at 529-550.

20. *Id.* at 526; *see also* Mary Christina Wood, *Atmospheric Trust Litigation*, *in* CLIMATE CHANGER READER (W.H. Rodgers, Jr. & M. Robinson-Dorn eds., Carolina Academic Press) (forthcoming 2009).

climate change. Moreover, the agency should be subject to strict judicial scrutiny when it attempts to eliminate the very resources that protect us from the deleterious effects of global warming.

II. The Statutory Framework

Taken together, the Healthy Forests Restoration Act ("HFRA") and the American Recovery and Reinvestment Act of 2009 ("ARRA") authorize the Forest Service to log 80 million acres of "hazardous fuels."[21] While the ARRA only allocates the funds necessary to carry out the statutory directives under the HFRA,[22] neither statute references any science used to determine the treatments which are necessary.

A. The Healthy Forests Restoration Act

This Act is doomed to failure in not protecting either small towns or big trees.

-Representative Jay Inslee[23]

Global warming is arguably the most far-reaching and formidable environmental issue facing the world.[24] "What we do in the next two to three years will determine our future. This is the defining moment."[25] And yet the Forest Service is carrying on with business as usual.[26] Despite global warming "catastrophes" that threaten numerous tree species,[27] the HFRA encourages the Forest Service to push forward with unnecessary logging sales that are contributing to the threat of all species' survival.[28]

21. Noelle Straub, *Key Appropriator Questions Wildfire Fund*, ENVT & ENERGY DAILY, Thursday, Apr. 2, 2009.

22. 123 Stat. 115 (Westlaw version at *170-71).

23. Molly Villamana, *House Passes Wildfire Bill After Fierce Debate*, ENVT & ENERGY DAILY, May 21, 2003 (quoting Representative Jay Inslee of Washington).

24. PEW CTR. ON GLOBAL CLIMATE CHANGE, U.S. TECHNOLOGY AND INNOVATION POLICIES, LESSONS FOR CLIMATE CHANGE (2003).

25. Elizabeth Rosenthall, *U.N. Chief Seeks More Leadership On Climate Change*, N.Y. TIMES, Nov. 18, 2007.

26. *See* Matthew Daly, *New Forest Service Chief Gets Rough Treatment in Congress*, ASSOCIATED PRESS, Feb. 14, 2007 (detailing Forest Service plans to double harvest levels (up to 800 million board feet in Washington, Oregon, and Northern California in fiscal year 2008)).

27. Every large, mature lodgepole pine forest in Colorado and southern Wyoming will be dead within three to five years. Todd Hartman, *Death of Trees "Catastrophic,"* ROCKY MOUNTAIN NEWS, Jan. 15, 2008; M. Martin Smith & Fiona Gow, *Unnatural Preservation*, HIGH COUNTRY NEWS, Feb. 4, 2008 ("[A] massive die-off" of pinon pine trees in the Southwest is being called a "global warming type event.").

28. 108 Pub. L. No. 148, 117 Stat. 1887 (codified at 16 U.S.C. §§ 6501-91 (2004)).

Aggressive fire suppression in fire-adapted ecosystems has kept fires out of our forests for the last century.[29] The prevalent mentality for the last 100 years has been that "wildfires are bad" and burned forests are "destroyed."[30] Forests that are "destroyed" have traditionally been viewed as having virtually no economic worth.[31] Thus, the agency has expended huge amounts of money and resources to prevent wildfires so that the trees could be logged instead.[32]

Many ecosystems have evolved with fire and some species' life strategies depend on severely burned forests to provide habitat.[33] It is now clear that a century of fire suppression was probably not the best management strategy. Nonetheless, Congress did not enact a statute to encourage fire back onto the landscape. Instead, it created HFRA[34] - a statute specifically designed to allow even more logging[35] with even less oversight and participation from the public.[36]

1. The (Lack of) Science Behind HFRA

Several key assumptions that were used to supply the rationale for HFRA are proving incorrect. First, the idea that "at risk communities" can be protected from fires by logging in areas more than a mile from the nearest structure has been disavowed by the agency's own scientists.[37] Second, the

29. GEORGE WUERTHNER, WILDFIRE: A CENTURY OF FAILED FOREST POLICY XV (George Wuerthner ed., Island Press 2006).

30. So says Smokey the Bear. http://www.smokeybear.com/good-bad.asp. This website is endorsed by the Forest Service. http://www.smokeybear.com/wildfires.asp

31. "Salvage" logging attempts to recover what little value is left. WUERTHNER, *supra* note 29, at 7.

32. *Id.*

33. *Id.*

34. 108 Pub. L. No. 148, 117 Stat. 1887 (codified at 16 U.S.C.A. §§ 6501-91 (West Supp. 2004)).

35. Jessie B. Davis, Comment, *The Healthy Forests Initiative: Unhealthy Policy Choices in Forest and Fire Management*, 34 ENVTL. L. 1209, 1209 (2004) ("[HFRA] seems calculated not to produce healthier forests, but greater timber harvests from public lands.").

36. *Id.* at 1243; *see* OFFICE OF TECHNOLOGY ASSESSMENT, U.S. CONGRESS, REPORT NO. OTA-F-505, FOREST SERVICE PLANNING: ACCOMMODATING USES, PRODUCING OUTPUTS, AND SUSTAINING ECOSYSTEMS (1992) (finding "most national forest managers still . . . believ[e] public participation is primarily an exercise in gathering information" rather than an integral part of the decision-making process); Sharon Buccino, NEPA *Under Assault: Congressional and Administrative Proposals Would Weaken Environmental Review and Public Participation*, 12 N.Y.U. ENVTL. L.J. 50 (2003).

37. Jack D. Cohen, Forest Service, What is the Wildland Fire Threat to Homes, Thompson Memorial Lecture at the School of Forestry at Northern Arizona University (Apr. 10, 2000) (hereinafter *Wildland*); U.S.D.A. FOREST SERVICE FIRE SCIENCES LABORATORY, EXPECTATION AND EVALUATION OF FUEL MANAGEMENT OBJECTIVES, 352, 358 (2003).

notion that "catastrophic" fires are threatening the health of ecosystems is belied by science that shows large, infrequent conflagrations have always been a part of the landscape and large buildups of understory fuels are not necessarily abnormal.[38] Third, the agency's newly minted position that restoring forests will increase sequestration and lessen the amount of carbon dioxide released into the atmosphere has not been scientifically proven. Science to the contrary is being published.[39]

a. 'At-Risk Communities'

HFRA authorizes logging projects to help protect "at-risk communit[ies]"[40] for "which a significant threat to human life or property exists as a result of a wildland fire disturbance event."[41] The statute allows logging in areas one and half miles or more away from the community that is supposedly at risk.[42] Despite these statutory authorizations, Forest Service researchers and other scientists have published a plethora of documents that indicate these logging projects are largely unneeded to protect homes from "catastrophic" fires.

"Research shows that a home's ignition potential during extreme wildfires is determined by the characteristics of its exterior materials and design and their response to burning objects within 100 feet (30 meters) and firebrands (burning embers) . . . . If homes do not ignite and burn during wildfires, then the W-UI fire problem largely does not exist."[43] "Home ignitions and, thus, the W-UI fire loss problem, principally depend on home ignitability. The home ignition zone extends to a few tens of meters around a home not hundreds of meters or beyond. Wildland fuel reduction beyond the home ignition zone does not necessarily change home ignitability; therefore, wildland fuel reduction does not necessarily mitigate the W-UI fire loss problem."[44]

38. Randall O'Toole, *U.S. Forest Service Has Money To Burn*, CATO INSTITUTE ("Most Western forests are ecologically adapted to catastrophic fires.") *available at* http://www.cato.org/pub_display.php?pub_id=8763.

39. Hanson, *supra* note 9.

40. 16 U.S.C. § 6511(a).

41. 16 U.S.C. § 6511(1)(c).

42. 16 U.S.C. § 6511(16); Remarkably, one study found that only 3% of the 44,000 fuels treatments implemented across the western United States were within the WUI. Tania Schoennagel, *Implementation of National Fire Plan Treatments Near the Wildland Urban Interface in the Western United States*, PROC. OF THE NAT'L ACAD. OF SCIENCES OF THE U.S., VOL. 106 NO. 26 10706-10711 (2009).

43. Jack Cohen, *The Wildland Urban Interface Fire Problem, A Consequence of the Fire Exclusion Paradigm*, FOREST HISTORY TODAY, 20, 22- 23 (2008).

44. Cohen, *Wildland*, *supra* note 37; U.S.D.A. Forest Serv. Fire Sciences Laboratory, *Expectation and Evaluation of Fuel Management Objectives*, 352, 358 (2003) ("Research findings indicate that a home's characteristics and the characteristics of a

The federal government is not only finding itself being confronted by its own scientists, but it is also footing the bill for what has likely become the largest unneeded insurance policy this country has ever seen.[45]

b. 'Catastrophic Fire'

Many believe that the forests are suffering from decades of aggressive fire suppression, resulting in an abnormal level of fuels on some forest floors.[46] This belief, that forests are unhealthy because of the amount of fuels on the landscape that could lead to catastrophic fires, serves as a core rationale for restoring forests under the HFRA.[47] The statute's goal of eliminating the "threats" of "catastrophic" wildfires[48] is drastically undercut by the science that says large conflagrations have always been on the landscape.[49]

Some forests have a fire interval of over 200 years, which would make these types of large "catastrophic" fires a normal, albeit infrequent, event.[50] In this light, it would not be unheard of to have dense forest stands.[51] The agency has largely avoided this issue by choosing to restore forest stands to a fixed, static point in time - usually right before the Forest Service began its fire suppression policy.[52] This practice has been questioned by Forest Service scientists:

> Current efforts to put management impacts into a historic context seem to focus almost exclusively on what amounts to a snapshot of vegetation history - a documentation of forest conditions near the time when European settlers first began to

home's immediate surroundings within 30 meters principally determine the potential for wildland-urban fire destruction.").

45. Cohen, *Wildland*, *supra* note 37, at 11-12.

("Instead of all pre-suppression and fire protection responsibilities residing with fire agencies, homeowners should take the principal responsibility for assuring adequately low home ignitability. The fire services become a community partner providing homeowners with the technical assistance needed for reducing home ignitability. This will require a change in the current relationship between fire agencies and homeowners from one of protector-victim to one of partners."); *see also It's the Forest Service, Not Fire Department*, MISSOULIAN, Dec. 24, 2006 (reporting that after the 2000 fires in Montana, "firefighters sheepishly conceded they'd spent more money protecting some buildings than the structures were worth.").'

46. *E.g.*, CAROLYN ALKIRE, THE WILDERNESS SOCIETY, THE FEDERAL WILDLAND FIRE BUDGET: LET'S PREPARE, NOT JUST REACT (Apr. 2004).

47. 16 U.S.C. § 6501(3).

48. *Id.*

49. O'Toole, *supra* note 38.

50. WUERTHNER, *supra* note 29, at 4.

51. *Id.*

52. *Id.*

> impact forest structure . . . I do not believe that historical ecology, emphasizing static conditions in recent times, say 100 years ago, will provide the complete picture needed to place present conditions in a proper historic context. Conditions immediately prior to industrial development may have been extraordinary compared to the past 1,000 years or more. Using forest conditions in the 1800s as a baseline, then, could provide a false impression if the baseline is considered a goal to strive toward.[53]

c. Restoration Equals Increased Sequestration

While the HFRA makes no mention of climate change, one of its purposes is to "enhanc[e] productivity and carbon sequestration."[54] As climate change becomes more of a priority to the Obama administration, the use of this previously glossed over reason for logging will likely gain prominence. The Forest Service Chief has already indicated how the agency is going to "reduce greenhouse gas buildups - through restoration activities and forest health improvements, . . . by increasing the amount of carbon stored in wood products, and by managing to reduce forest fire emissions."[55] In essence, this statement reveals two new positions the agency has not previously invoked - thinning out trees will increase carbon sequestration while reducing forest fire emissions; and the amount of carbon stored in wood products can be increased. These positions have superficial appeal. Taking these positions to their logical extreme, however, would allow the agency to cut down all the trees in the forest to reduce forest fire emissions and increase the amount of carbon stored in wood products.[56] The Chief has acknowledged this tension.[57]

Therein lies the problem - the agency does not have the science to determine at a site-specific level how much logging (if any) is necessary to increase sequestration.[58] Some scientists are denouncing this new agency position with science that shows cutting down trees exacerbates and perpetuates the climate crisis by releasing more carbon dioxide into the

53. U.S.D.A. FOREST SERV., FLAMMULATED, BOREAL, AND GREAT GRAY OWLS IN THE U.S.: A TECHNICAL CONSERVATION ASSESSMENT 209 (G.D. Hayward & J. Verner eds., 1994).

54. 16 U.S.C. § 6501(6)(c) (2006).

55. Kimbell, *Managing Forests*, *supra* note 14.

56. *Id.*

57. Kimbell, *Forest Management*, *supra* note 1 ("[k]eeping forests in forests is key to protecting carbon stores.").

58. Kimbell, *Managing Forests*, *supra* note 14.

atmosphere than would otherwise be released by a wildfire.[59] Moreover, "most of the carbon from a felled tree is either burned as slash or as 'hog fuel' from mill residue; only about 15% becomes some type of durable wood product . . .[and] the half-life of these 'durable' wood products is less than 40 years."[60] Due to the shift in focus with the new administration, the agency has found itself scrambling for science to support its position.[61]

B. The Costs of a Statute Unmoored From Science

The agency is no longer the U.S. Forest Service, but rather the U.S. Fire Service.

-U.S. Rep. Nick Rahall[62]

The costs of fire fighting and suppression are "out of control."[63] The 2008 fire season alone cost taxpayers over 1.4 billion dollars,[64] and only half the amount of money allocated to reduce the risk of fire to communities was used in W-UI related projects.[65] To make matters worse:

> These [hazardous fuels] treatments will not easily pay for themselves. Although high commercial value of large logs can fund a timber-harvest operation, vegetation removed for fuel hazard reduction is not so marketable. Small-diameter trees currently are in low demand, and the market values are low in some areas of the country. In the Interior West, the demand for small diameter trees and other material is among the lowest and the need to remove such trees is among the greatest.
>
> Currently the technologies and the economic incentive for using these small diameter trees are minimal, and often the cost of

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59. Hanson, *supra* note 9 ("Whatever carbon emissions occur from combustion during wildland fire and subsequent decay of fire-killed trees is more than balanced by forest growth across the landscape over time.") (citations omitted).

60. *Id.* (citation omitted).

61. Kimbell, *Managing Forests*, *supra* note 14; U.S.D.A. FOREST SERVICE, FOREST SERVICE STRATEGIC FRAMEWORK FOR RESPONDING TO CLIMATE CHANGE (Oct. 2, 2008).

62. Noelle Straub, *Key Appropriator Questions Wildfire Fund*, ENVT. & ENERGY DAILY, Thursday, Apr. 2, 2009 (quoting Rep. Nick Rahall, D-W.Va., chairman of the House Natural Resources Committee).

63. *Id.* (quoting Norm Dicks); Matthew Daly, *House Approves Special Funding to Fight Wildfires*, ASSOCIATED PRESS, Mar. 26, 2009 (according to Rep. Nick Rahall, D-W.Va., chairman of the House Natural Resources Committee, "about half of the Forest Service budget is now devoted to fire suppression and prevention").

64. Bettina Boxall, *Spending to Fight California Wildfires Tops 1 Billion*, LOS ANGELES TIMES, Dec. 31, 2008.

65. ALKIRE, *supra* note 46.

transportation exceeds the market value of the material.[66]

Moreover, Obama's quarter billion dollar allocation to reduce hazardous fuels on private lands should be seen for what it is - a caving in to a very small number of private property owners[67] that refuse to take responsibility for their own actions.[68] The HFRA disregards all the science that says logging is largely not necessary in the W-UI and invokes private property rights rhetoric that triggers a "politics of fear [that] shift[s] our attention toward the personal losses we might sustain rather than collective losses we are all enduring."[69] It is simply inequitable to force taxpayers to bestow a dubious benefit upon a small group when a true benefit could accrue to the public as a whole.[70] If the taxpayers are going to subsidize logging projects to benefit private homeowners, the projects should only take place where they are scientifically justified - within thirty meters of the landowners' homes.

C. The American Recovery and Reinvestment Act of 2009: Change We Can Believe In, Or More of The Same?

President Barack Obama has repeatedly emphasized the importance of using sound science to guide policy:

> Science and the scientific process must inform and guide decisions of my Administration on a wide range of issues, including . . . protection of the environment, and . . . mitigation of the threat of climate change . . . The public must be able to trust the science and scientific process informing public policy decisions.[71]

To ensure science guides the decision-making process, President

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66. U.S. FOREST SERVICE, FIRE AND FUELS BUILDUP, 3 (Position Paper) *available at* http://www.fs.fed.us/publications/

67. "Only 14 percent of private land adjacent to forests has homes on it." Ray Rasker, *Now's the Time to Tackle Forest Fire Fighting Costs*, NEW WEST,Apr. 9, 2009.

68. To be fair, the problem isn't confined to the west. Coastal inhabitants expect taxpayers to provide federal flood insurance (levees), and then file takings claims when they can't build in areas that are prone to flooding. *See* Christine A. Klein, *Mississippi River Stories: Lessons From a Century of Unnatural Disasters*, 60 SMU L. REV. 1471 (2007).

69. *See* Zach Welcker, *Welcome Speech to the 25th Annual Public Interest Environmental Law Conference: Cultivating Corridors for the People: The Next Twenty-Five Years*, 22 J. ENVTL L. & LITIG. 197, 197 (2007)

70. *See* Christine A. Klein, *The New Nuisance: An Antidote to Wetlands Loss, Sprawl, and Global Warming*, 48 B.C. L. REV. 1155, 1197 (2007).

71. Exec. Mem., *Scienfitic Integrity*, Mar. 9, 2009 *available at* http://www.white house.gov/the_press_office/Memorandum-for-the-Heads-of-Executive-Departments-and-Agencies-3-9-09/).

Obama has directed the various federal agencies to use peer-reviewed science in decision-making and to make the science available to the public.[72]

The American Recovery and Reinvestment Act of 2009 allocates 250 million dollars to the Forest Service for hazardous fuels reduction, forest health protection, rehabilitation and hazard mitigation activities on Federal lands.[73] Another quarter billion dollars was allocated for state and private forestry activities targeting the same.[74] Despite the President's strong rhetoric on placing science above politics, it appears he will stay the course with former President George W. Bush's policies on hazardous fuels treatments.

An Obama campaign flyer admitted that "[r]educing the dangers of wildfires cannot be addressed through federal action alone," but failed to address the agency's own science that indicates hazardous fuels treatments on federal lands in the W-UI are mostly damaging ecosystems and further degrading the atmosphere.[75] On a positive note, money was authorized to take care of land within the thirty meters next to private landowners homes.[76] Unfortunately, the large allocation of money geared towards federal lands projects, coupled with the absence of any new Congressional or Executive oversight, signals the likely continuance of an expensive and flawed policy divorced from science.

III. Historical Agency Directives

The Forest Service has failed to take on its share of the responsibility for fighting global warming.[77] This shouldn't come as a surprise. After all, the agency has a statutory mandate to provide for "timber,"[78] and a long

72. *Id.*

73. 123 Stat. 115 (Westlaw version at *170-71).

74. *Id.*

75. OBAMA-BIDEN: COMMITTED TO WILDFIRE MANAGEMENT & COMMUNITY PROTECTION, www.barackobama.com/pdf/issues/Fact_Sheet_Wildfire.pdf.

76. *Supra*, note 67.

77. GENERAL ACCOUNTING OFFICE, CLIMATE CHANGE: AGENCIES SHOULD DEVELOP GUIDANCE FOR ADDRESSING THE EFFECTS OF FEDERAL LAND AND WATER RESOURCES (Aug.2007) ("[R]esource managers have limited guidance about whether or how to address climate change and, therefore, are uncertain about what actions, if any, they should take. In general, resource managers lack specific guidance for incorporating climate change into their management actions and planning efforts. Without such guidance, their ability to address climate change and effectively manage resources is constrained."); *Bosworth, supra* note 10 ("At the Forest Service, we owe it to the people we serve to become more carbon-neutral.").

78. 16 U.S.C. § 528 ("It is the policy of the Congress that the National Forests are established and shall be administered for outdoor recreation, range, *timber*, watershed, and wildlife and fish purposes.") (emphasis added).

history of elevating that mandate over most others.[79]

According to early U.S. mentality, forests were a negative resource,[80] and an impediment to agriculture and home to wild animals and savage natives.[81] As Eastern U.S. cities began to burgeon and timber became increasingly scarce, many began to view timber as a positive resource.[82] Forest reserves were created in response to a timber industry that ravaged immense tracts of virgin timber.[83] The Forest Service was created in 1905 and was charged with managing the forest reserves.[84] Early scientific forestry, sought to place forests under the control of official bodies with the principal aim of ensuring sustained supplies of timber to strategic industries.[85] The prevailing belief was that industrial forestry was justifiable in the public interest, as it would generate jobs, wealth and development that would promote general prosperity.[86] For over sixty years the Forest Service operated under the Organic Act's[87] mandate of providing timber and water.[88] The Act provided relatively little substantive guidance and thus offered the Forest Service a large amount of discretion in managing the nation's forests.[89]

Congress passed the Multiple Use Sustained Yield Act of 1960 (MUSY)

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79. DAINA DRAVNIEKS APPLE, U.S.D.A. FOREST SERVICE, CHANGING SOCIAL AND LEGAL FORCES AFFECTING THE MANAGEMENT OF NATIONAL FORESTS (1997) (citations omitted) (available at http://www.fs.fed.us/publications/).

80. Marion Clawson, *Forests in the Long Sweep of American History*, 204 SCIENCE 4398, 1168-74 (June 15, 1979).

81. *Van Ness v. Pacard*, 27 U.S. (2 Pet.) 137, 145 (1829) ("The country was a wilderness, and the universal policy was to procure its cultivation and improvement."); David N. Bengston, et al., *Shifting Forest Value Orientations in the United States, 1980–2001: A Computer Content Analysis*, 13 ENVTL.VALUES 373, 374 (2004).

82. Bengston, *supra* note 81, at 374.

83. Jack Tuholske & Beth Brennan; *The National Forest Management Act: Judicial Interpretation of a Substantive Environmental Statute*, 15 PUB. LAND L. REV. 53, 57 (1994).

84. *Id.* at 57.

85. MARCUS COLCHESTER ET AL., CENTER FOR INTERNATIONAL FORESTRY RESEARCH BRIDGING THE GAP: COMMUNITIES, FORESTS AND INTERNATIONAL NETWORKS (2003).

86. *Id.*

87. The Forest Reserve Act of 1891 and the Organic Administration Act of 1897 state that "No national forest reservations shall be established except to improve and protect the forest within the reservation, or for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States . . . ." 30 Stat. 35 (1897) (codified as 16 U.S.C. § 475 (1994)).

88. Act of Mar. 6, 1891, 26 Stat. 1103, repealed by 90 Stat. 2792 (1976).

89. Tuholske, *supra* note 77 at 59-60.

to direct the Forest Service to mange for other resources.[90] Despite the new multiple use mandate, MUSY arguably did little to change forest management direction.[91] As the west continued to experience explosive growth, conflicting demands upon the various resources of the national forests grew, and commodity production has increasingly collided with resource protection and recreational use.[92]

IV. Current Statutory Directives

Our environmental statutes have largely failed to protect the public from global warming.[93] The situation is especially dire in the public land management context. There is a statutory framework devoid of science that is encouraging the agency to contribute to carbon dioxide emissions. There is also a total lack of substantive statutory authority addressing climate change.

A. The National Forest Management Act of 1976

The National Forest Management Act of 1976 ("NFMA")[94] was passed in response to a controversy over Forest Service clear-cutting and other industrial logging practices.[95] At one point, the NFMA was deemed to be "the most complete forestry legislation ever passed."[96] While it is still an impressive piece of legislation, it lacks enforceable standards that would require the agency to stop its unnecessary contributions to climate change.[97]

The NFMA requires the agency to prepare a Renewable Resource Assessment ("RPA").[98] The RPA is designed to gather the information necessary to properly manage those resources and make informed policy

90. Multiple Use Sustained Yield Act of 1960, 16 U.S.C. §§ 528-531 (1998) (adding recreation, wildlife, fish, and range resources to the list of resources to be managed.).

91. *See Perkins v. Bergland*, 608 F.2d 803, 807 (9th Cir. 1979)_("[MUSY] breathes discretion at every pore.").

92. Tuholske, *supra* note 83, at 54.

93. *See* Wood, *supra* note 20, .at 21 (observing that while "the vast body of statutory law was designed to safeguard natural resources for the American Public, the law itself has become a major engine of environmental destruction.").

94. 16 U.S.C. §§ 1600-1614 (1988) (amending Forest and Rangeland Renewable Resources Planning Act of 1974).

95. *See* Tuholske, *supra* note 83 for an in-depth analysis of the events that catalyzed enactment of the statutes that have governed the Forest Service since the agency's inception.

96. Arnold W. Bolle, *The Bitterroot Re-visited: A University Re-View of the Forest Service*, 10 PUB. LAND L. REV. 1, 15 (1989).

97. 16 U.S.C. §§ 1600-1614 (1988).

98. 16 U.S.C. §1601(a).

decisions.[99] The emphasis has broadened over time, from a solely economic concern with supply and demand to concern about resource conditions, ecosystem health, and sustainability.[100]

The report must contain an analysis of the present and potential future uses of the forests,[101] potential effects of global climate change on the forests,[102] and an analysis of the opportunities to "mitigate the buildup of atmospheric carbon dioxide and reduce the risk of global climate change."[103] A 1988 amendment to the act entitled the "Forest Ecosystems and Atmospheric Pollution Research Act of 1988" requires the Service to "study the relationship between atmospheric pollution and other factors that affect forest health"[104] and to develop recommendations for mitigating the effects of atmospheric pollution on the health of the forests.[105] Nonetheless, the amendment and the outcomes of the studies do not require the agency to act in any particular way.

An RPA addressing climate change is expected to be released in 2010.[106] Given the Forest Service's timber production mandate and its seeming propensity to solve its problems by cutting down more trees, the agency report and resulting orientation towards climate change will likely be business as usual. In short, NFMA's requirement to study the climate change problem and make recommendations for how the agency can help solve the problem is not going to require the Forest Service to curtail its pollution problem.[107]

B. The National Environmental Policy Act

If a person were to read the National Environmental Policy Act ("NEPA") for the first time without knowing anything about its subsequent case law, they might say the statue has the potential to stop global warming.

99. U.S.D.A. Forest Service, *The RPA Assessment: Past, Present, and Future*, *available at* http://www.fs.fed.us/research/rpa/what.shtml.

100. *Id.*

101. 16 U.S.C. § 1601(a)(1).

102. 16 U.S.C. § 1601(a)(5).

103. 16 U.S.C. § 1601(a)(6).

104. 16 U.S.C. § 1642(c)(1)(D).

105. 16 U.S.C. § 1642(c)(1)(E).

106. RPA *Assessment*, *supra* note 99.

107. Despite requiring climate change research, the findings section of the Forest and Rangeland Renewable Resources Research Act substantiates claims that the agency is more concerned with increasing timber production than doing its part to curb global warming. *See* 16 U.S.C. §§ 1641(a)(5-6) ("Increasing regulatory burdens . . . is causing the domestic wood and paper producers to move outside the United States . . . Wood and Paper producers are being challenged . . . by shifts in Federal Government policy . . . Wood production per acre will need to quadruple from 1996 levels for the United States forestry sector to remain internationally competitive.").

The language is progressive: It recognizes the impacts humans are having on the environment and charges the Federal Government with trustee duties so that future generations can exist:

> The Congress, recognizing the profound impact of man's activity on the interrelations of all components of the natural environment, particularly the profound influences of population growth, . . . resource exploitation, . . . recognizing further the critical importance of restoring and maintaining environmental quality to the overall welfare and development of man, declares that it is the continuing policy of the Federal Government . . . to use all practicable means and measures . . . in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.[108]
>
> [I]t is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may[109] . . . *fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.*[110]

To be sure, courts have concluded that climate change is a legitimate environmental issue that must be addressed with NEPA analysis and failure to discuss the impacts of climate change open the agency up to litigation.[111] Nonetheless, requiring a discussion of impacts does not require the agency to reduce carbon dioxide emissions from the proposed project.[112] The

108. 42 U.S.C. § 4331(a) (1969).

109. 42 U.S.C. § 4331(b)

110. 42 U.S.C.§ 4331(b)(1)

111. *Border Power Plant Working Group v.* DOE involved a challenge to a proposal to construct transmission lines that would transport electricity from Mexican power plants to the California Grid. 260 F. Supp. 2d 997 (S.D. Cal. 2003). Plaintiffs challenged the Department of Energy and the Bureau of Land Management for inadequate NEPA analysis regarding the agencies' failure to evaluate the impacts of emissions from the Mexican power plants. The court held that failure to "disclose and analyze" the impacts of carbon dioxide emissions is "counter to NEPA." *Id.* at 1028-29.

112. *Mid States Coalition for Progress v. Surface Transportation Board* concerned a challenge to a proposed 280-mile railroad line that would have hauled coal from Wyoming to coal-fired power plants in the Midwest. 472 F.3d 545 (8th Cir. 2006). Petitioners challenged the agency for failing to analyze the possibility that an increase of coal into the market would result in increases in the amount of carbon dioxide released into the atmosphere. While the judge sided with environmentalists and remanded back to the agency, the 8th Circuit sided with the railroad's

procedural statute merely requires the Forest Service to adequately tell us how approving its next logging sale will further pollute the environment and lead to "disastrous consequences in many parts of the world."[113]

No, that isn't a typo.[114] In sum, NEPA is "ineffective" at reducing our carbon footprint.[115]

V. The Public Trust Doctrine

The public trust doctrine has been a consistent piece of fodder amongst environmental intellectuals for decades.[116] Thus, the tiny proportion of attention devoted to the doctrine in judicial forums is notable. Some attribute the dearth of litigation to the federal statutory scheme,[117] but this criticism is quickly becoming outdated with the lack of statutory climate change directives aimed at the various land management agencies.

In American jurisprudence, the public trust doctrine emerged as a method for states to protect limited environmental interests, such as coastal waterways and fishing areas, which were reserved for the benefit of the public and distinguished from grants of private ownership.[118] As the doctrine has evolved, modern scholars have increasingly begun to cite changing public needs such as improved air and water quality along with the conservation of the natural landscape, as a basis for expanding the public trust doctrine.[119]

A. Forests As a Trust Resource in England

The roots of the public trust doctrine run deep. Most scholars trace them to a 1500-year-old Roman textbook known as the Institutes of

Supplemental Environmental Impact Statement in the second round of litigation - which did not involve mitigation. *Mayo Found. v. Surface Transp. Bd.*, 472 F.3d 545, 556 (8th Cir. 2006).

113. Kimbell, *Managing Forests*, *supra* note 14.

114. *E.g.*, *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 353 n.16 (1989) (stating that NEPA imposes no substantive requirement that mitigation measures actually be taken).

115. Kevin T. Haroff & Katherine Kirwan Moore, *The Domestic Response to Global Climate Change: Federal, State, and Litigation Initiatives*, 42 U.S.F. L. REV. 155, 169 (2007).

116. *E.g.*, Joseph L. Sax, *The Public Trust Doctrine in Natural Resources Law: Effective Judicial Intervention*, 68 MICH. L. REV. 471, 474 (1970).

117. Richard J. Lazarus, *Changing Conceptions of Property and Sovereignty in Natural Resources: Questioning the Public Trust Doctrine*, 71 IOWA L. REV. 631, 701 (1986) (declaring the "doctrine simply has no place in this emerging scheme."); J.B. Ruhl, *Ecosystem Services and the Common Law of "The Fragile Land System,"* 20 NAT. RESOURCES & ENV'T 3, 6 (2005).

118. George Smith, *The Public Trust Doctrine and Natural Law: Emanations Within a Penumbra*, 33 B.C. ENVTL. AFF. L. REV. 307, 307 (2006).

119. *Id.*

Justinian.[120] Taken together, the core principals assert that certain natural resources cannot pass into private ownership.[121]

This principle came to England with the Romans and was adopted into the Magna Carta.[122] The Magna Carta, which King John of England was forced to sign in 1215, established forests and fisheries as res communes.[123] Clause 20 in the 1217 text of the Magna Carta makes it clear that the Magna Carta was drafted after a decision had been taken to make a separate charter for forests.[124] This is important not only because the Charter of the Forest both complements and supplements the Magna Carta, but also for the explicit weight it places on forests and the resources they provided citizens. Moreover, the Charter of the Forest was issued again in 1225, alongside a reissue of the Magna Carta.[125]

In comparison with the Magna Carta, the Charter of the Forest provided real rights, privileges, and protections for the common man against abuses of encroaching aristocracy.[126] The Charter came at a time when the Royal Forests were the most important potential source of fuel for cooking, heating and industries such as charcoal burning.[127] The charter was unique in providing a degree of economic protection for serfs and vassals.[128] While most U.S. Citizens no longer rely on the forests for the same reasons as our medieval British counterparts, the forests are still being relied upon for survival.[129]

B. The Public Trust Doctrine in Federal Land Management

"[T]he public lands are held in trust for all the people of the United

120. *E.g.*, J.B. Ruhl & James Salzman, *Ecosystem Services and the Public Trust Doctrine: Working Change From Within*, 15 SOUTHEASTERN ENVTL. L. J. 223, 224 (2006).

121. Joseph L. Sax, *Liberating the Public Trust Doctrine From its Historical Shackles*, 14 U.C. DAVIS L. REV. 186 (1980).

122. Ruhl, *supra* note 117, at 224.

123. Peter Barnes, *Capitalism 3.0: A Guide to Reclaiming the Commons* 1, 15-16 (2006).

124. John Langton, *The Charter of the Forest of King Henry* III, http://info.sjc.ox.ac.uk/ forests/Carta.htm, (last visited Oct. 19, 2008).

125. *Id.*

126. *Forest Laws*, Encyclopedia Britannica, (11th ed. 1911), http://www.1911encyclo pedia.org/Forest_laws.

127. Sources of English Constitutional History, King Henry III: Charter of the Forest (1217), http://www.constitution.org/sech/sech_045.htm, (last visited Oct. 19, 2008).

128. *Id.*

129. *See* Kimbell, *Forest Management, supra* note ("America's forests offset about 10 percent of our country's carbon emissions."); INGERSON, *supra* note 4 ("Given the right policies that proportion could reach as high as 36%.").

States"[130] and the "Forest Service is the custodian and protector of the forests."[131] If federal agencies have a trustee duty in administering public lands, it follows that the duty can be breached.

Sierra Club v. Department of the Interior, commonly known as *Redwoods* II, is most likely the high water mark to date for such a theory.[132] The litigation involved logging operations on private lands adjacent to Redwood National Park.[133] The Sierra Club filed suit and took the position that the National Park Service should take various actions to protect the parklands from the effects of logging.[134] The court found the Park Service to be a trustee on behalf of the public and ordered the Park Service to use all of its powers to protect the area in question from adjacent logging, to attempt to negotiate contracts with private loggers and to consider acquiring private lands.[135] The court even ordered the Park Service to lobby Congress for funds to buy out adjacent private landowners.

While *Redwoods* II can be characterized as a vigorous application of the trust doctrine, the case can be read in a more limited way.[136] The court relied on both the National Park Service Organic Act and the Redwood National Park Act.[137] Both statutes contained language that could be read as imposing an express trust, rather than an implied trust that is typically associated with public lands.[138] Additionally, the preservation mandate placed on the Park Service to maintain parks in an "unimpaired" state for future generations lends itself well to applying the public trust doctrine to constrain agency action compared to an agency like the Forest Service. In other words, the Park Service has a much purer mandate that is more

130. *Light v. United States*, 220 U.S. 523, 537 (1911); *Knight v. United States Land Ass'n*, 142 U.S. 161, 181 (1891) (stating the federal government is the "guardian of the people of the United States over public lands.").

131. *West Virginia Div. of Izaak Walton League of America v. Butz*, 522 F.2d 945, 955 (4th Cir. 1975) ("[T]he Forest Service regarded itself as a custodian and protector of the forests rather than a prime producer, and consistent with this role the Service faithfully carried out the provisions of the Organic Act with respect to selective timber cutting."); *see also Dred Scott v. Sanford*, 60 U.S. 393, 448 (1856). ("[Land] was acquired by the General Government, as the representative and trustee of the people of the United States, and it must therefore be held in that character for their common and equal benefit[.]"). Despite the obvious toxicity of this case, it offers positive support for the propositions here.

132. *Sierra Club v. Department of the Interior*, 398 F. Supp. 284 (1975).

133. *Id.*

134. *Id.*

135. *Id.* at 293.

136. Charles Wilkinson, *The Public Trust Doctrine in Public Land Law*, 14 U.C. DAVIS L. REV. 269, 310-13 (1980).

137. 398 F. Supp. at 311.

138. Charles F. Wilkinson, *The Field of Public Land Law: Some Connecting Threads and Future Direction*, 1 PUB. LAND L. REV. 1, 25 (1980).

hospitable to the public trust doctrine.

C. New Approaches For Using the Doctrine to Combat Climate Change

While federal courts have had no problem applying the public trust doctrine against the federal government in the submerged lands context,[139] some consider the doctrine to be the proverbial sword in the stone in the public land management context.[140] Applying the doctrine against the federal government can generally occur at either the legislative or administrative levels, with application of the doctrine against the Forest Service being the more realistic approach.

1. Invalidating Legislation That is Not Scientifically Grounded

Mention of applying the public trust doctrine against the federal government frequently stops with the U.S. Supreme Court case *Light v. United States*:

> It is not for the courts to say how that trust shall be administered. That is for Congress to determine. The courts cannot compel it to set aside the lands for settlement, or to suffer them to be used for agricultural or grazing purposes, nor interfere when, in the exercise of its discretion, Congress establishes a forest reserve for what it decides to be national and public purposes. In the same way and in the exercise of the same trust it may disestablish a reserve, and devote the property to some other national and public purpose.[141]

The key to this paragraph is that the court will not interfere when the property is devoted to some other "national and public purpose." Timber sales that would not occur but for private homes should not be considered a benefit to the public. Nonetheless, the Supreme Court has deferred wildly to Congress when determining what is a public purpose.[142] The courts'

139. *E.g.*, *United States v. 1.58 Acres of Land*, 523 F. Supp. 120 (D. Mass 1981) (holding the federal government cannot abdicate trust resources.); *Lake Michigan Federation v. U.S. Army Corps of Engineers*, 742 F. Supp. 446 (D. Ill. 1990) ("The very purpose of the public trust doctrine is to police the legislature's disposition of public lands.").

140. *E.g.*, Eric Person, *The Public Trust Doctrine in Federal Law*, 24 J. LAND RESOURCES & ENVTL. L. 173, 176-77 (2004).

141. *Light*, 220 U.S. at 537.

142. *Id.*

major hang-up appears to be when the Property Clause[143] meets the public trust doctrine.[144] Some have argued that the public trust doctrine has an implicit home in the Constitution.[145] Still, at least one prominent scholar does not believe a constitutionally based trust doctrine would be enforceable against Congress.[146] In spite of the fact that the drafters of the HFRA did not cite to any science to determine that "catastrophic" forest fires are "threat" to forests and communities, the Supreme Court's interpretation of the Property Clause will likely pose a substantial barrier to success.

2. Using The Public Trust to Guide Agency Decision-Making

The application of the public trust doctrine to state and federal public lands is consistent with its creation in the Charter of the Forest - both provide a check on power. The King's rule in England or contemporary agency actions in the U.S. Courts have held that the Forest Service is the trustee for the people of the United States.[147] The principles of the public trust doctrine can help inform the limits of the agency's discretion in managing our trust assets. Two main principles are applicable here: (1) the agency should use the best available science when determining how best to manage the public's resources, and (2) an agency's attempts to dispose of trust resources to benefit a small group of private individuals is susceptible to judicial review.[148]

a. Requiring the Use of the Best Available Science

Some have suggested that the public trust doctrine be applied when

143. Congress' ability to manage federal lands and its resources arises from the Property Clause of the Constitution. U.S. Const. art. 4, § 3. ("Congress shall have power to dispose of and make all needful rules and regulations respecting the territory or other property belonging to the United States."). The Supreme Court in *Kleppe v. New Mexico* had occasion to interpret the clause: "[W]hile the furthest reaches of the property clause have not yet been definitely resolved, we have repeatedly observed that '[t]he power over the public lands thus entrusted to Congress is without limitations." 426 U.S. 529 (1976).

144. *See* Wilkinson, *supra* note 136 ("It is possible that courts today would find that the property clause includes some general trust notions.").

145. Douglas L. Grant, *Underpinnings of the Public Trust Doctrine: Lessons From Illinois Central Railroad*, 33 ARIZ. ST. L.J. 849 (2001) (surveying Supreme Court decisions regarding the doctrine and arguing that the Court invoked the Ninth Amendment by implication in *Illinois Central*).

146. *E.g.*, Wilkinson, *supra* note 136 at 306.

147. *Light*, 220 U.S. at 537.

148. Torres, *supra* note 18; Professor Sax has asked whether Congress could sell a National Park to a private individual. Joseph L. Sax, *The Public Trust Doctrine in Natural Resources Law: Effective Judicial Intervention*, 68 MICH. L. REV. 471, 480 (1970).

legislature has not passed legislation regarding the resource in question.[149] In essence, those advocating for such a position are trying to use the public trust doctrine to act as a regulatory gap filler - thus creating a cornerstone of environmental common law. As Joseph Sax has pointed out:

> A conceptual vacuum exists because individual rights in public land other than those specifically created by acts of the legislative body do not exist in English or American law. As a consequence, the only reliable way to challenge agency actions pertaining to land management is through a statute that applies to the particular problem. If there is not a specific statute that covers the point in question, relief will be difficult to obtain.[150]

Even though Joseph Sax's seminal work on the public trust doctrine spoke to state development of the trust doctrine, he posited that the doctrine could fill in the conceptual common law vacuum described above when he stated:

> Of all the concepts known to American law, only the public trust doctrine seems to have the breadth and substantive content which might make it useful as a tool of general application for citizens seeking to develop a comprehensive legal approach to resource management problems.[151]

In the climate change context, there is a regulatory gap in the science underlying the decision-making process. Requiring the agency to use the best available science to inform and guide decisions when using statutes that are not clearly based on science is a value-neutral approach that would create a judicially enforceable standard to ensure the agency is acting as a responsible trustee of our resources when determining what projects to undertake. For example, the Forest Service would be required to produce science that shows structures would be at risk from wildfires if the contemplated logging project did not occur. The agency would not be permitted to undertake a logging project if it could not support its decision with verifiable science. This approach would ensure the agency is protecting the public from climate change by only undertaking logging projects that are necessary.

149. *E.g.*, John E. Montgomery, *The Public Trust Doctrine in Public Land Law: Its Application in the Judicial Review of Land Classification Decisions*, 8 WILLAMETTE L. REV. 135, 177 (1972).

150. Sax, *supra* note 116.

151. *Id.* at 474; *see also* J.B. Ruhl, *Ecosystem Services and the Common Law of "The Fragile Land System,"* 20 NAT. RESOURCES & ENV'T 3, (2005) (arguing that nuisance can fill the regulatory gaps.).

b. Scrutiny Before Destruction of a Trust Resource

Courts have expanded the trust doctrine far beyond its original reaches.[152] Nonetheless, the fact that air is an enumerated trust resource[153] has been largely overlooked for the last 1500 years.[154] To be sure, air is a trust resource[155] and important for our survival.[156] Courts have held that the public trust doctrine constrains activities that would otherwise degrade a resource covered by the doctrine.[157] Because trees are a trust resource and also produce a trust resource, it is not far-fetched to think the doctrine could apply to land management agencies.[158] By prohibiting an agency from cutting down trees that contain and produce a trust resource, ancillary benefits are gained - carbon stays stored in trees.[159]

It has been posited that the public trust doctrine should grant equitable relief when governmental agencies attempt to shift or divert a trust resource from one specific public use to a new and inappropriate one, and where a course of agency action is being pursued in derogation of the trust use which has the effect of either destroying the resource or giving rise to its pollution.[160] These principles are applicable and overlap in the public

152. *Marks v. Whitney*, 6 Cal. 3d 251 (1971) (ecological values); *Caminiti v. Boyle*, 732 P.2d 989, 994 (Wash. 1987) (swimming, water skiing); *In re Water Permit Applications*, 9 P.3d 409 (Haw. 2000) (doctrine covers groundwater); *Pullen v. Ulmer*, 923 P.2d 54 (Alaska 1996) (doctrine covers fish in their natural state); *Vander Bloemen v. Wisc. Dep't of Nat. Resources*, 1996 WL 346266 (Wis. Ct. App. 1996) (doctrine protects lakeside ecology); *Aspen Wilderness Workshop, Inc. v. Colo. Water Conservation Bd.*, 901 P.2d 1251 (Colo. 1995) (state must avoid injury to creek from ski resort's water request).

153. J. Inst. 2.1.1 in Thomas Cooper, The Institutes of Justinian 67, 67 (3d ed. J.S. Voorhies 1852).

154. Indeed, what may have been a one word rhetorical flourish 15 centuries ago is acting as an anchor today for multiple attempts to put the entire atmosphere into a world-wide trust. *E.g.*, Torres, *supra* note 18; Wood, *supra* note 20.

155. *Nat'l Audubon Soc'y v. Super. Ct.*, 33 Cal. 3d 419, 437 (1983) ("The purity of the air . . . is among the purposes of the public trust.") (*citing Marks v. Whitney*, 6 Cal. 3d 251, 259-260) (1971) (linking the "climate of the area" to the preservation of tidelands).

156. Indeed, there is an entire statutory scheme designed to protect air and our atmosphere in general. Clean Air Act, 42 U.S.C. § 7401 *et seq*.

157. *Nat'l Audubon Soc'y*, 33 Cal. 3d at 437.

158. *See Selkirk-Priest Basin Ass'n, Inc. v. Idaho ex rel. Andrus*, 899 P.2d 949, 952-54 (Idaho 1995) (doctrine allows challenge to timber sales on ground that sedimentation could injure fish spawning grounds); *see also id.*

159. *See* Richard Birdsey, Ralph Allg & Darlus Adams, Mitigation Activities in the Forest Sector to Reduce Emissions and Enhance Sinks of Greenhouse Gases, in The Impact of Climate Change on America's Forests: A Technical Document Supporting the 2000 USDA Forest Service RPA Assessment 113-15 (Linda A. Joyce & Richard Birdsey eds. 2000).

160. Sax, *supra* note 116, at 477.

lands context, but are necessarily constrained by the notion that the doctrine cannot serve as an inflexible bar to all dispositions.[161] Thus, a narrowing of the application that allows the agency discretion to manage the resource by using the best available science, while providing the public a judicial check when the agency seeks to abdicate a trust resource is appropriate.[162]

Under HFRA, the Forest Service can log in the "Wildland Urban Interface," an amorphous definition that sometimes encompasses an area over a mile and a half away from the nearest home or structure.[163] Logging in the Wildland Urban Interface to save structures that are not in danger of fires is a diversion of the trees that were storing air, resulting in an impermissible abdication of a trust resource. In this instance it would be appropriate to apply the doctrine against the government to maintain the use of the resource for the public. When the agency acts to alienate the resource to the detriment of other rightful claimants, it should have a high burden of justification that it must meet, akin to strict scrutiny.[164]

VI. Conclusion

"Air pollution ... has resulted in mounting dangers to the public health and welfare."[165] The Forest Service has acknowledged that global warming underlies many problems with forest management,[166] and that it can manage for increased carbon sequestration to combat global warming.[167] The agency can and must do some belt-tightening to control the amount of air pollution it is contributing to the atmosphere.[168] Unfortunately, it has taken a back-seat approach to the climate catastrophe and has failed to make any commitments or set any targets for lowering its carbon footprint.

161. Joseph Sax has cautioned against such inflexibility: "[I]t is inconceivable that the trust doctrine should be viewed as a rigid prohibition, preventing all dispositions of trust property or utterly freezing as of a given moment the uses to which those properties have traditionally been put." Joseph L. Sax, *Liberating the Public Trust Doctrine from Its Historical Shackles*, 14 U.C. DAVIS L. REV. 185, 186 (1980).

162. *See id.*

163. 16 U.S.C. § 6511(16).

164. Torres, *supra* note 18, at 573.

165. Clean Air Act, 42 U.S.C. § 7401(a)(2).

166. Bosworth, *supra* note 10 ("[W]e are coming to see that climate change is part of the underlying problem - and a common thread.").

167. U.S.D.A. FOREST SERVICE, FOREST SERVICE STRATEGIC FRAMEWORK FOR RESPONDING TO CLIMATE CHANGE 10 (OCT. 2, 2008); Kimbell, *Managing Forests*, *supra* note 14 ("America's forests offset about 10 percent of our country's carbon emissions. It could be more, depending on how we manage forests in the future.").

168. As Professor Wood Points out: "the hopeful aspect of a society built upon waste is that we can make some major cuts without compromising our basic needs." Wood, *supra* note 20.

It appears the Forest Service would rather maintain its discretion to destroy our atmosphere and stick to the same empty rhetoric,[169] flawed policies,[170] and non-existent science that provide unnecessary benefits for private land owners at the expense of the public.[171]

"The mission of the Forest Service is to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations."[172] If the agency wants to stay true to its mission, it can longer afford to approve unneeded logging projects that are adding air pollution to our atmosphere. The Forest Service must take further steps to protect the public from climate change.

The current environmental statutes governing public land management cannot be relied upon to curb the looming climate catastrophe. The public trust doctrine may be able to slow down the rate at which the Forest Service is polluting by requiring the agency to use the best available science when planning logging projects and subjecting the agency to substantive judicial review when it seeks to destroy trust resources for a private purpose.

To be sure, the federal public lands are at the outer limits of the public trust doctrine.[173] But as Justice Oliver Wendell Holmes once said: the law is "[t]he felt necessities of the times."[174] As we increasingly find ourselves in a carbon constrained world, new avenues must be explored to require the federal government to re-examine its role in degrading our atmosphere.

169. Jessie B. Davis, Comment, *The Healthy Forests Initiative: Unhealthy Policy Choices in Forest And Fire Management*, 34 ENVTL. L. 1209, 1242-45 (2004). HFRA's policies are based on "the dubious - if not false - premise[s]: that: (1) public participation in forest management issues has only limited value, and (2) NEPA is the "enemy of forest health and public safety."

170. *Id.*

171. *Id.*

172. Kimbell, *Forest Research*, *supra* note 4.

173. Wilkinson, *supra* note 136, at 273.

174. O.W. HOLMES, THE COMMON LAW (1881).