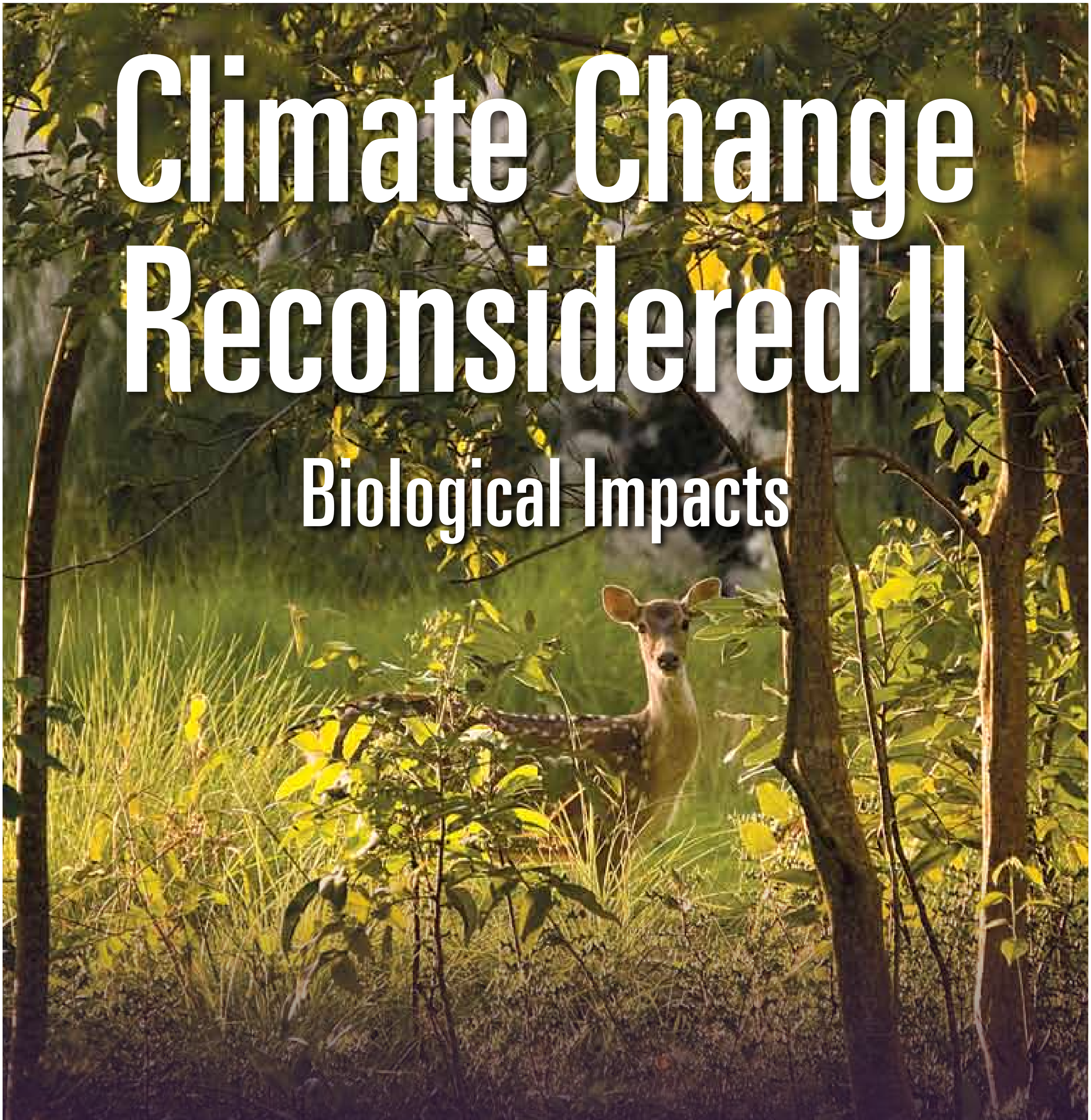
Climate Change Reconsidered II

Biological Impacts



Summary for Policymakers

NIPCC

NONGOVERNMENTAL INTERNATIONAL PANEL
ON CLIMATE CHANGE

About NIPCC and Its Previous Reports

The Nongovernmental International Panel on Climate Change, or NIPCC, as its name suggests, is an international panel of scientists and scholars who came together to understand the causes and consequences of climate change. NIPCC has no formal attachment to or sponsorship from any government or government agency.

NIPCC seeks to objectively analyze and interpret data and facts without conforming to any specific agenda. This organizational structure and purpose stand in contrast to those of the United Nations' Intergovernmental Panel on Climate Change (IPCC), which *is* government-sponsored, politically motivated, and predisposed to believing that climate change is a problem in need of a U.N. solution.

NIPCC traces its beginnings to an informal meeting held in Milan, Italy in 2003 organized by Dr. S. Fred Singer and the Science & Environmental Policy Project (SEPP). The purpose was to produce an independent evaluation of the available scientific evidence on the subject of carbon dioxide-induced global warming in anticipation of the release of IPCC's *Fourth Assessment Report* (AR4). NIPCC scientists concluded IPCC was biased with respect to making future projections of climate change, discerning a significant human-induced influence on current and past climatic trends, and evaluating the impacts of potential carbon dioxide-induced environmental changes on Earth's biosphere.

To highlight such deficiencies in IPCC's AR4, in 2008 SEPP partnered with The Heartland Institute to produce *Nature, Not Human Activity, Rules the Climate.* In 2009, the Center for the Study of Carbon Dioxide and Global Change joined the original two sponsors to help produce *Climate Change Reconsidered: The 2009 Report of the Nongovernmental International Panel on Climate Change (NIPCC)*, the first comprehensive alternative to the alarmist reports of IPCC.

In 2010, a Web site (www.nipccreport.org) was created to highlight scientific studies NIPCC scientists believed likely would be downplayed or ignored by IPCC during preparation of its next assessment report. In 2011, the three sponsoring organizations produced *Climate Change Reconsidered: The 2011 Interim Report of the Nongovernmental International Panel on Climate Change (NIPCC)*.

In 2013, a division of the Chinese Academy of Sciences translated and published an abridged edition of the 2009 and 2011 NIPCC reports in a single volume. Also in 2013, NIPCC released *Climate Change Reconsidered II: Physical Science,* the first of three volumes bringing the original 2009 report up-to-date with research from the 2011 *Interim Report* plus research as current as the third quarter of 2013. A new Web site was created (www.ClimateChangeReconsidered.org) to feature the new report and news about its release.

The second volume in the *Climate Change Reconsidered II* series, subtitled *Biological Impacts*, is the subject of this *Summary for Policymakers.* A third and final volume, subtitled *Human Welfare, Energy, and Policies,* is also being released in 2014 and is accompanied by its own *Summary for Policymakers*.

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Climate Change Reconsidered II: Biological Impacts
2014 Report of the Nongovernmental International Panel on Climate Change (NIPCC)

Summary for Policymakers

Lead Authors/Editors

Craig D. Idso (USA), Sherwood B. Idso (USA), Robert M. Carter (Australia), S. Fred Singer (USA)

Contributing Authors and Reviewers

David J. Barnes (Australia), Raymond A. Cloyd (USA), Susan Crockford (Canada), Weihong Cui (China), Kees DeGroot (The Netherlands), Robert G. Dillon (USA), John Dale Dunn (USA), Ole Henrik Ellestad (Norway), Fred Goldberg (Sweden), Barry Goldman (Australia), H. Dickson Hoese (USA), Morten Jødal (Norway), Madhav Khandekar (Canada), Miroslav Kutilek (Czech Republic), Steven W. Leavitt (USA), Howard Maccabee (USA), Jennifer Marohasy (Australia), Cliff Ollier (Australia), Jim Petch (United Kingdom), Robert J. Reginato (USA), Paul Reiter (France), Tom Segalstad (Norway), Gary Sharp (USA), Walter Starck (Australia), David Stockwell (Australia), Mitchell Taylor (Canada), Gerd Weber (Germany), Bastow Wilson (New Zealand), Raphael Wust (Australia)

Several additional reviewers wish to remain anonymous.

Editors

Diane Carol Bast (USA), S.T. Karnick (USA)

NIPCC

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Introduction

The human impact on global climate is small, and any warming that may occur as a result of human carbon dioxide (CO_2) and other greenhouse gas emissions is likely to have little effect on global temperatures, the cryosphere (ice-covered areas), hydrosphere (oceans, lakes, and rivers), or weather. (See Figure 1.)

Climate Change Reconsidered II: Biological Impacts (CCR-IIb), the subject of this *Summary for Policymakers,* examines the scientific research on the impacts of rising temperatures and atmospheric CO_2 levels on the biological world (Idso *et al.*, 2014). It finds no net harm to the global environment or to human health and often finds the opposite: net benefits to plants, including important food crops, and to animals and human health. (See Figure 2.)

Climate Change Reconsidered II: Biological Impacts is the second of three volumes in the Climate Change Reconsidered II series produced by the Nongovernmental International Panel on Climate Change (NIPCC). Together, they represent the most comprehensive and authoritative independent review of climate science available from any source. They were commissioned and are offered as an alternative to the alarmist reports of the United Nations' Intergovernmental Panel on Climate Change (IPCC).

The first volume in the Climate Change Reconsidered II series, subtitled *Physical Science,* was released in September 2013. It demonstrated there is no dangerous human interference in Earth's climate. This finding by itself is logically sufficient to dismiss nearly all of the negative climate-related impacts predicted by IPCC. Nevertheless, there is a huge literature on the impacts, costs, and benefits of rising temperatures and atmospheric CO_2 levels that demonstrates climate change, whether natural or man-made, is not a crisis. *Climate Change Reconsidered II: Biological Impacts* expertly surveys that literature.

Biological Impacts broadly tracks and critiques the work of IPCC's Working Group II, which is expected to release its report on the impacts of climate change around the same time as this report is presented. It appears IPCC is continuing its pattern of selectively reporting data to present an alarmist view of the impacts of climate change.

Figure 1.
Physical Science Summary

- Global climate models are unable to make accurate projections of climate even 10 years ahead, let alone the 100-year period that has been adopted by policy planners. The output of such models should therefore not be used to guide public policy formulation.
- Neither the rate nor the magnitude of the reported late twentieth century surface warming (1979–2000) lay outside the range of normal natural variability, nor were they in any way unusual compared to earlier episodes in Earth's climatic history.
- Solar forcing of temperature change is likely more important than is currently recognized.
- No unambiguous evidence exists of dangerous interference in the global climate caused by human-related CO_2 emissions. In particular, the cryosphere is not melting at an enhanced rate; sea-level rise is not accelerating; and no systematic changes have been documented in evaporation or rainfall or in the magnitude or intensity of extreme meteorological events.
- Any human global climate signal is so small as to be nearly indiscernible against the background variability of the natural climate system. Climate change is always occurring.
- A phase of temperature stasis or cooling has succeeded the mild warming of the twentieth century. Similar periods of warming and cooling due to natural variability are certain to occur in the future irrespective of human emissions of greenhouse gases.

Source: Idso, C.D., Carter R.M., and Singer, S.F. (Eds.) 2013. *Climate Change Reconsidered II: Physical Science.* Chicago, IL: The Heartland Institute.

Figure 2.
Biological Impacts Summary

- **Atmospheric carbon dioxide is not a pollutant.** It is a non-toxic, non-irritating, and natural component of the atmosphere. Long-term CO_2 enrichment studies confirm the findings of shorter-term experiments, demonstrating numerous growth-enhancing, water-conserving, and stress-alleviating effects of elevated atmospheric CO_2 on plants growing in both terrestrial and aquatic ecosystems.

- **The ongoing rise in the air's CO_2 content is causing a great greening of the Earth.** All across the planet, the historical increase in the atmosphere's CO_2 concentration has stimulated vegetative productivity. This observed stimulation, or greening of the Earth, has occurred in spite of many real and imagined assaults on Earth's vegetation, including fires, disease, pest outbreaks, deforestation, and climatic change.

- **There is little or no risk of increasing food insecurity due to global warming or rising atmospheric CO_2 levels.** Farmers and others who depend on rural livelihoods for income are benefitting from rising agricultural productivity throughout the world, including in parts of Asia and Africa where the need for increased food supplies is most critical. Rising temperatures and atmospheric CO_2 levels play a key role in the realization of such benefits.

- **Terrestrial ecosystems have thrived throughout the world as a result of warming temperatures and rising levels of atmospheric CO_2.** Empirical data pertaining to numerous animal species, including amphibians, birds, butterflies, other insects, reptiles, and mammals, indicate global warming and its myriad ecological effects tend to foster the expansion and proliferation of animal habitats, ranges, and populations, or otherwise have no observable impacts one way or the other. Multiple lines of evidence indicate animal species are adapting, and in some cases evolving, to cope with climate change of the modern era.

- **Rising temperatures and atmospheric CO_2 levels do not pose a significant threat to aquatic life.** Many aquatic species have shown considerable tolerance to temperatures and CO_2 values predicted for the next few centuries, and many have demonstrated a likelihood of positive responses in empirical studies. Any projected adverse impacts of rising temperatures or declining seawater and freshwater pH levels ("acidification") will be largely mitigated through phenotypic adaptation or evolution during the many decades to centuries it is expected to take for pH levels to fall.

- **A modest warming of the planet will result in a net reduction of human mortality from temperature-related events.** More lives are saved by global warming via the amelioration of cold-related deaths than those lost under excessive heat. Global warming will have a negligible influence on human morbidity and the spread of infectious diseases, a phenomenon observed in virtually all parts of the world.

Source: Idso, C.D., Idso, S.B., Carter, R.M., and Singer, S.F. (Eds.) 2014. *Climate Change Reconsidered II: Biological Impacts.* Chicago, IL: The Heartland Institute.

A draft of Working Group II's forthcoming *Summary for Policymakers* identifies eight "key risks" (IPCC 2013a):

i. Risk of death, injury, and disrupted livelihoods in low-lying coastal zones and small island developing states, due to sea-level rise, coastal flooding, and storm surges.

ii. Risk of food insecurity linked to warming, drought, and precipitation variability, particularly for poorer populations.

iii. Risk of severe harm for large urban populations due to inland flooding.

iv. Risk of loss of rural livelihoods and income due to insufficient access to drinking and irrigation water and reduced agricultural productivity, particularly for farmers and pastoralists with minimal capital in semi-arid regions.

v. Systemic risks due to extreme events leading to breakdown of infrastructure networks and critical services.

vi. Risk of loss of marine ecosystems and the services they provide for coastal livelihoods, especially for fishing communities in the tropics and the Arctic.

vii. Risk of loss of terrestrial ecosystems and the services they provide for terrestrial livelihoods.

viii. Risk of mortality, morbidity, and other harms during periods of extreme heat, particularly for vulnerable urban populations.

The findings summarized in Figure 2 effectively refute five of these apocalyptic forecasts. The remaining three "key risks"—the harm that coastal and inland flooding will do to people and to infrastructure—are addressed in the first and third volumes of the Climate Change Reconsidered II series.

1. Impact on Plants and Soil

Carbon dioxide is the basis of nearly all life on Earth. It is the primary raw material utilized by most plants to produce the organic matter from which they construct their tissues. Not surprisingly, thousands of laboratory and field experiments conducted over the past 200 years demonstrate that plant productivity and growth both rise as the CO_2 concentration of the air increases.

As early as 1804, de Saussure showed that peas exposed to high CO_2 concentrations grew better than control plants in ambient air; and work conducted in the early 1900s significantly increased the number of species in which a growth-enhancing effect of atmospheric CO_2 enrichment was observed to occur (Demoussy, 1902-1904; Cummings and Jones, 1918). By the time a group of scientists convened at Duke University in 1977 for a workshop on Anticipated Plant Responses to Global Carbon Dioxide Enrichment, an annotated bibliography of 590 scientific studies dealing with CO_2 effects on vegetation had been prepared (Strain, 1978). This body of research demonstrated increased levels of atmospheric CO_2 generally produce increases in plant photosynthesis, decreases in plant water loss by transpiration, increases in leaf area, and increases in plant branch and fruit numbers, to name but a few of the most commonly reported benefits.

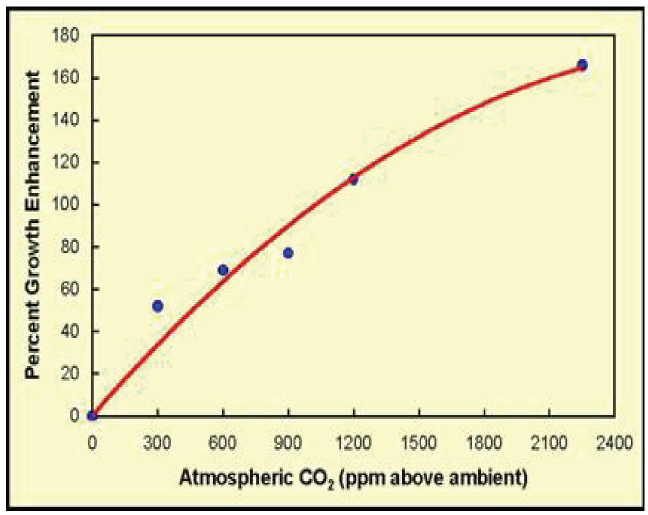

Figure 3. **Positive Impact of CO2 on Plants and Trees.** Adapted from Idso, K.E. (1992).

Five years later, at the International Conference on Rising Atmospheric Carbon Dioxide and Plant Productivity, it was concluded a doubling of the air's CO_2 concentration likely would lead to a 50% increase in photosynthesis in C_3 plants, a doubling of water use efficiency in both C_3 and C_4 plants, significant increases in biological nitrogen fixation in almost all biological systems, and an increase in the ability of plants to adapt to a variety of environmental stresses (Lemon, 1983). In the years since, many other studies have been conducted on hundreds of different plant species, repeatedly confirming the growth-enhancing, water-saving, and stress-alleviating advantages that elevated atmospheric CO_2 concentrations bestow upon Earth's plants and soils (Idso and Singer, 2009; Idso and Idso, 2011).

Chapter 1 focuses on basic plant productivity responses to elevated CO_2 and includes in two appendices tabular presentations of more than 5,500 individual plant photosynthetic and biomass responses to CO_2-enriched air, finding nearly all plants experience increases in these two parameters at higher levels of CO_2. Chapter 1 also examines the effect of elevated CO_2 on ecosystems including forests, grasslands, peatlands, wetlands, and soils. This review of the literature reveals elevated CO_2 improves the productivity of ecosystems both in plant tissues aboveground and in the soils beneath them. The key findings of Chapter 1 are presented in Figure 4.

2. Impact on Plant Characteristics

There are two principal methods researchers utilize to ascertain how Earth's terrestrial plants will be affected by a continuation of the historical rise in the atmosphere's CO_2 concentration. One way is to grow plants in CO_2-enriched air to levels expected to be experienced in the decades and centuries to come. In the case of long-lived trees, growth over prior decades and centuries as the CO_2 concentration has risen can be derived from studying the yearly growth rings produced over those time periods and that now comprise the living or dead trees' trunks.

The primary information sought in these studies are rates of photosynthesis and biomass production and the efficiency with which the various plants and trees utilize water. There are a host of other effects of significance, including substances produced in the growth process that impact how well it proceeds, substances deposited in the parts of agricultural crops that are harvested for human and animal consumption, and substances that determine whether insect pests find the foliage or fruit of a certain crop or tree to be to their liking. Finally, there is the question of whether forest soils will have sufficient nitrogen to sustain the long-term CO_2-enhanced growth rates of long-lived trees.

Chapter 2 examines these and other effects of atmospheric CO_2 enrichment on plant characteristics. Extensive research finds those effects are overwhelmingly positive. For example, rising CO_2 levels promote plant growth by increasing the concentrations of plant hormones that stimulate cell division, cell elongation, and protein synthesis; by enabling plants to produce more and larger flowers; by increasing the production of glomalin, an important protein created by fungi living in symbiotic association with the roots of most vascular plants; and by affecting leaf characteristics of agricultural plants that lead to higher rates and efficiencies of photosynthesis and growth as well as increased resistance to herbivory and pathogen attack. The key findings of Chapter 2 are presented in Figure 5.

3. Impact on Plants Under Stress

According to IPCC, a warmer future will introduce new sources of stress on the biological world, including increases in forest fires, droughts, and extreme heat events. IPCC fails to ask whether the higher levels of atmospheric CO_2 its models also predict will aid or hinder the ability of plants to cope with these challenges. Had it looked, IPCC would have discovered an extensive body of research showing how atmospheric CO_2 enrichment ameliorates the negative effects of a number of environmental plant stresses. The relative percentage growth enhancement produced by an increase in the air's CO_2 concentration is generally greater under stressful and resource-limited conditions than when growing conditions are ideal.

The impact of rising atmospheric CO_2 on plants under stress is the subject of Chapter 3, and key findings from that chapter appear in Figure 6.

4. Likely Future Impacts on Plants

Chapter 4 analyzes how atmospheric CO_2 enrichment has boosted global food production and biospheric productivity since the beginning of the Industrial Revolution. It also reports how rising CO_2 helps plants avoid temperature-induced extinctions, which many models predict could occur if global temperatures rise significantly in the future. Whereas

Figure 4.
Key Findings: CO_2, Plants, and Soils

- Results obtained under 3,586 separate sets of experimental conditions conducted on 549 plant species reveal nearly all plants experience increases in dry weight or biomass in response to atmospheric CO_2 enrichment. Additional results obtained under 2,094 separate experimental conditions conducted on 472 plant species reveal nearly all plants experience increases in their rates of photosynthesis in response to atmospheric CO_2 enrichment.

- Long-term CO_2 enrichment studies confirm the findings of shorter-term experiments, demonstrating that the growth-enhancing, water-conserving, and stress-alleviating effects of elevated atmospheric CO_2 likely persist throughout plant lifetimes.

- Forest productivity and growth rates throughout the world have increased gradually since the Industrial Revolution in concert with, and in response to, the historical increase in the air's CO_2 concentration. Therefore, as the atmosphere's CO_2 concentration continues to rise, forests will likely respond by exhibiting significant increases in biomass production and they likely will grow more robustly and significantly expand their ranges.

- Modest increases in air temperature tend to increase carbon storage in forests and their soils. Thus, old-growth forests can be significant carbon sinks and their capacity to sequester carbon in the future will be enhanced as the air's CO_2 content continues to rise.

- As the atmosphere's CO_2 concentration increases, the productivity of grassland species will increase even under unfavorable growing conditions characterized by less-than-adequate soil moisture, inadequate soil nutrition, elevated air temperature, and physical stress imposed by herbivory.

- The thawing of permafrost caused by increases in air temperature will likely not transform peatlands from carbon sinks to carbon sources. Instead, rapid terrestrialization likely will act to intensify carbon-sink conditions.

- Rising atmospheric CO_2 concentrations likely will enhance the productivity and carbon sequestering ability of Earth's wetlands. In addition, elevated CO_2 may help some coastal wetlands counterbalance the negative impacts of rising seas.

- Rising atmospheric CO_2 concentrations likely will allow greater numbers of beneficial bacteria (that help sequester carbon and nitrogen) to exist within soils and anaerobic water environments, thereby benefitting both terrestrial and aquatic ecosystems.

- The aerial fertilization effect of atmospheric CO_2 enrichment likely will result in greater soil carbon stores due to increased carbon input to soils, even in nutrient-poor soils and in spite of predicted increases in temperature. The carbon-sequestering capability of Earth's vegetation likely will act as a significant brake on the rate-of-rise of the air's CO_2 content and thereby help to mute the magnitude of any CO_2-induced global warming.

- The historical increase in the air's CO_2 content has significantly reduced the erosion of valuable topsoil over the past several decades; the continuing increase in atmospheric CO_2 can maintain this trend and perhaps even accelerate it for the foreseeable future.

Source: Chapter 1. "CO_2, Plants, and Soils," *Climate Change Reconsidered II: Biological Impacts* (Chicago, IL: The Heartland Institute, 2014).

Figure 5.
Key Findings: Plant Characteristics

- Atmospheric CO_2 enrichment (henceforth referred to as "rising CO_2") enhances plant growth, development, and ultimate yield (in the case of agricultural crops) by increasing the concentrations of plant hormones that stimulate cell division, cell elongation, and protein synthesis.

- Rising CO_2 enables plants to produce more and larger flowers, as well as other flower-related changes having significant implications for plant productivity and survival, almost all of which are positive.

- Rising CO_2 increases the production of glomalin, a protein created by fungi living in symbiotic association with the roots of 80 percent of the planet's vascular plants, where it is having a huge positive impact on the biosphere.

- Rising CO_2 likely will affect many leaf characteristics of agricultural plants, with the majority of the changes leading to higher rates and efficiencies of photosynthesis and growth as well as increased resistance to herbivory and pathogen attack.

- Rising CO_2 stimulates photosynthesis in nearly all plants, enabling them to produce more nonstructural carbohydrates that can be used to create important carbon-based secondary compounds, one of which is lignin.

- Rising CO_2 leads to enhanced plant fitness, flower pollination, and nectar production, leading to increases in fruit, grain, and vegetable yields of agricultural crops as well as productivity increases in natural vegetation.

- As rising CO_2 causes many plants to increase biomass, the larger plants likely will develop more extensive root systems enabling them to extract greater amounts of mineral nutrients from the soil.

- Rising CO_2 causes plants to sequentially reduce the openness of their stomata, thus restricting unnecessary water loss via excessive transpiration, while some plants also reduce the density (number per area) of stomates on their leaves.

- Rising CO_2 significantly enhances the condensed tannin concentrations of most trees and grasses, providing them with stronger defenses against various herbivores both above and below ground. This in turn reduces the amount of methane, a potent greenhouse gas, released to the atmosphere by ruminants browsing on tree leaves and grass.

- As the air's CO_2 content rises, many plant species may not experience photosynthetic acclimation even under conditions of low soil nitrogen. In the event that a plant cannot balance its carbohydrate sources and sinks, CO_2-induced acclimation provides a way of achieving that balance by shifting resources away from the site of photosynthesis to enhance sink development or other important plant processes.

Source: Chapter 2. "Plant Characteristics," *Climate Change Reconsidered II: Biological Impacts* (Chicago, IL: The Heartland Institute, 2014).

Figure 6.
Key Findings: Plants Under Stress

- Atmospheric CO_2 enrichment (henceforth referred to as "rising CO_2") exerts a greater positive influence on diseased as opposed to healthy plants because it significantly ameliorates the negative effects of stresses imposed on plants by pathogenic invaders.

- Rising CO_2 helps many plants use water more efficiently, helping them overcome stressful conditions imposed by drought or other less-than-optimum soil moisture conditions.

- Enhanced rates of plant photosynthesis and biomass production from rising CO_2 will not be diminished by any global warming that might accompany it in the future. In fact, if ambient air temperatures rise concurrently, the growth-promoting effects of atmospheric CO_2 enrichment will likely rise even more.

- Although rising CO_2 increases the growth of many weeds, the fraction helped is not as large as that experienced by non-weeds. Thus, CO_2 enrichment of the air may provide non-weeds with greater protection against weed-induced decreases in productivity.

- Rising CO_2 improves plants' abilities to withstand the deleterious effects of heavy metals where they are present in soils at otherwise-toxic levels.

- Rising CO_2 reduces the frequency and severity of herbivory against crops and trees by increasing production of natural substances that repel insects, leading to the production of more symmetrical leaves that are less susceptible to attacks by herbivores, and making trees more capable of surviving severe defoliation.

- Rising CO_2 increases net photosynthesis and biomass production by many agricultural crops, grasses, and grassland species even when soil nitrogen concentrations tend to limit their growth. Additional CO_2-induced carbon input to the soil stimulates microbial decomposition and thus leads to more available soil nitrogen, thereby conclusively disproving the progressive nitrogen limitation hypothesis.

- Rising CO_2 typically reduces and can completely override the negative effects of ozone pollution on the photosynthesis, growth, and yield of nearly all agricultural crops and trees that have been experimentally evaluated.

- Rising CO_2 can help plants overcome stresses imposed by the buildup of soil salinity from repeated irrigation.

- The ongoing rise in the air's CO_2 content is a powerful antidote for the deleterious biological impacts that might be caused by an increase in the flux of UV-B radiation at the surface of Earth due to depletion of the planet's stratospheric ozone layer.

Source: Chapter 3. "Plants Under Stress," *Climate Change Reconsidered II: Biological Impacts* (Chicago, IL: The Heartland Institute, 2014).

IPCC projects severe food shortages in the future resulting from CO_2-induced weather-related phenomena, the preponderance of evidence suggests the many yield-enhancing benefits of rising atmospheric CO_2 will ensure enough food is grown to feed the growing population of the planet.

Chapter 4 also reports on the current health of the terrestrial biosphere, analyzing the productivity of the globe as a whole followed by regional analyses on continental and sub-continental scales. According to IPCC, the productivity of the terrestrial biosphere should be declining from rising temperatures and other perceived negative climatic changes. In contrast, empirical data show it to be increasing, in large measure due to the aerial fertilization effect of rising atmospheric CO_2.

Chapter 4 concludes with an examination of topics pertaining to biodiversity, plant extinctions, and plant evolution, which represent three important topics in assessing the state of Earth's future terrestrial biosphere. The key findings of this chapter are presented in Figure 7.

5. Impact on Terrestrial Animals

IPCC's *Fourth Assessment Report* claimed "new evidence suggests that climate-driven extinctions and range retractions are already widespread" and the "projected impacts on biodiversity are significant and of key relevance, since global losses in biodiversity are irreversible (*very high confidence*)" (IPCC, 2007). However, as shown in the first volume of the Climate Change Reconsidered II series, *Physical Science,* there is a growing divide between IPCC's climate model simulations and real-world observations of global warmth. The species-modeling research IPCC almost exclusively relies on to make these predictions depends on climate models known to exaggerate future global warming and extreme weather events.

Even assuming IPCC climate models were unbiased and reasonably accurate at regional scales, the "climate envelope" models used by IPCC are deeply flawed due to assumptions about the immobility of species that are routinely contradicted by real-world observations. IPCC also improperly characterizes the adaptive responses (e.g., range shifts, phenotypic or genetic adaptations) of many species as supporting their model-based extinction claims, when in reality such adaptive responses provide documentary evidence of species resilience.

Chapter 5 begins with a review and analysis of IPCC-based species extinction claims, highlighting many of the problems inherent in the models on which such claims are based. The model projections are then evaluated against real-world observations of various animal species and their response to what IPCC has called the unprecedented rise in atmospheric CO_2 and temperature of the twentieth and twenty-first centuries. Results of that evaluation reveal that although there likely will be some changes in species population dynamics, few (if any) likely will be driven even close to extinction. In a number of instances, real-world data indicate warmer temperatures and higher atmospheric CO_2 concentrations will be highly beneficial, favoring a proliferation of species. IPCC continues to ignore such positive externalities of rising temperature and atmospheric CO_2.

Key findings from Chapter 5 appear in Figure 8.

Polar bears have survived historic changes in climate that have exceeded those of the twentieth century or are forecast by computer models to occur in the future.

Figure 7.
Key Findings: Earth's Vegetative Future

- The vigor of Earth's terrestrial biosphere has been increasing with time, revealing a great post-industrial revolution greening of the Earth that extends across the entire globe. Over the past 50 years global carbon uptake has doubled from 2.4 ± 0.8 billion tons in 1960 to 5.0 ± 0.9 billion tons in 2010.

- The atmosphere's rising CO_2 content, which IPCC considers to be the chief culprit behind all of its "reasons for concern" about the future of the biosphere, is most likely the primary cause of the observed greening trend.

- The observed greening of the Earth has occurred in spite of all the many real and imagined assaults on Earth's vegetation, including fires, disease, pest outbreaks, air pollution, deforestation, and climatic change. Rising levels of atmospheric CO_2 are making the biosphere more resilient to stress even as it becomes more lush and productive.

- Agricultural productivity in the United States and across the globe dramatically increased over the last three decades of the twentieth century, a phenomenon partly due to new cultivation techniques but also due partly to warmer temperatures and higher CO_2 levels.

- A future warming of the climate coupled with rising atmospheric CO_2 levels will further boost global agricultural production and help to meet the food needs of the planet's growing population.

- The positive direct effects of CO_2 on future crop yields are likely to dominate any hypothetical negative effects associated with changing weather conditions, just as they have during the twentieth and early twenty-first centuries.

- Plants have a demonstrated ability to adjust their physiology to accommodate a warming of both the magnitude and rate-of-rise typically predicted by climate models, should such a warming actually occur.

- Evidence continues to accumulate for substantial heritable variation of ecologically important plant traits, including root allocation, drought tolerance, and nutrient plasticity, which suggests rapid evolution is likely to occur based on epigenetic variation alone. The ongoing rise in the air's CO_2 content will exert significant selection pressure on plants, which can be expected to improve their performance in the face of various environmental stressors via the process of micro-evolution.

- As good as things currently are for world agriculture, natural selection and bioengineering could bring about additional beneficial effects. For example, highly CO_2-responsive genotypes of a wide variety of plants could be selected to take advantage of their genetic ability to optimize their growth in response to projected future increases in the air's CO_2 content.

Source: Chapter 4. "Earth's Vegetative Future," *Climate Change Reconsidered II: Biological Impacts* (Chicago, IL: The Heartland Institute, 2014).

Figure 8.
Key Findings: Terrestrial Animals

- IPCC's forecast of future species extinction relies on a narrow view of the literature that is highly selective and based almost entirely on model projections as opposed to real-world observations; the latter often contradict the former.
- Numerous shortcomings are inherent in the models utilized in predicting the impact of climate on the health and distributions of animal species. Assumptions and limitations make them unreliable.
- Research suggests amphibian populations will suffer little, if any, harm from projected CO_2-induced global warming, and they may even benefit from it.
- Although some changes in bird populations and their habitat areas have been documented in the literature, linking such changes to CO_2-induced global warming remains elusive. Also, when there have been changes, they often are positive, as many species have adapted and are thriving in response to rising temperatures of the modern era.
- Polar bears have survived historic changes in climate that have exceeded those of the twentieth century or are forecast by computer models to occur in the future. In addition, some populations of polar bears appear to be stable despite rising temperatures and summer sea ice declines. The biggest threat they face is not from global warming but hunting by humans, which historically has taken a huge toll on polar bear populations.
- The net effect of climate change on the spread of parasitic and vector-borne diseases is complex and at this time appears difficult to predict. Rising temperatures increase the mortality rates as well as the development rates of many parasites of veterinary importance, and temperature is only one of many variables that influence the range of viruses and other sources of diseases.
- Existing published research indicates rising temperatures likely will not increase, and may decrease, plant damage from leaf-eating herbivores, as rising atmospheric CO_2 boosts the production of certain defensive compounds in plants that are detrimental to animal pests.
- Empirical data on many other animal species, including butterflies, other insects, reptiles, and other mammals, indicate global warming and its myriad ecological effects tend to foster the expansion and proliferation of animal habitats, ranges, and populations, or otherwise have no observable impacts one way or the other.
- Multiple lines of evidence indicate animal species are adapting, and in some cases evolving, to cope with climate change of the modern era, as expected by Darwinian evolution and well-established ecological concepts.

Source: Chapter 5. "Terrestrial Animals," *Climate Change Reconsidered II: Biological Impacts* (Chicago, IL: The Heartland Institute, 2014).

6. Impact on Aquatic Life

IPCC postulates that human interference in the climate will significantly harm aquatic life by causing temperatures of the world's water bodies to rise and through the absorption of CO_2 from the atmosphere into water, thereby lowering the pH of freshwater and ocean water (a process referred to as "acidification"). In both scenarios, IPCC projects marine and freshwater species will be negatively impacted and will experience future declines, which, in some instances, may be so severe as to cause species extinctions.

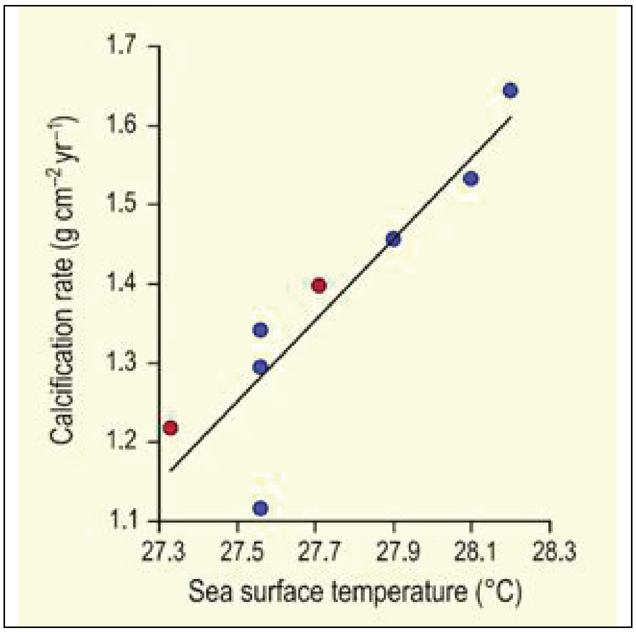

Figure 9. Coral calcification rates rise with seawater temperature. Adapted from Carricart-Ganivet and Gonzalez-Diaz (2009).

In contrast, the material presented in Chapter 6, representing the findings of hundreds of peer-reviewed research analyses, suggests a much better future is in store for Earth's aquatic life. Many laboratory and field studies demonstrate growth and developmental improvements in response to higher temperatures and reduced water pH levels. Other research illustrates the capability of both marine and freshwater species to tolerate and adapt to the rising temperature and pH decline of the planet's water bodies. When these observations are considered, the pessimistic projections of IPCC give way to considerable optimism with respect to the future of the planet's marine life.

The key findings of this chapter, which challenge the alarming and negative projections of IPCC, are presented in Figure 10.

7. Impact on Human Health

Carbon dioxide (CO_2) is invisible, odorless, nontoxic, and does not seriously affect human health until the CO_2 content of the air reaches approximately 15,000 ppm, more than 37 times greater than the current concentration of atmospheric CO_2 (Luft *et al.*, 1974). There is no reason to be concerned about any direct adverse human health consequences of the ongoing rise in the air's CO_2 content now or in the future, as even extreme model projections do not indicate anthropogenic activities will raise the air's CO_2 concentration above 1,000 to 2,000 ppm. Nevertheless, IPCC contends rising CO_2 concentrations are causing several indirect threats to human health, which they project will worsen as the air's CO_2 concentration rises in the future.

In a draft Technical Summary of its upcoming report, Working Group II claims, "The health of human populations is sensitive to shifts in weather patterns and other aspects of climate change [*very high confidence*] and "There is emerging evidence of non-linearities in response (such as greater-than-expected mortality due to heat waves) as climates become more extreme" (IPCC, 2013b).

Research reviewed in *CCR-IIb,* however, shows IPCC's view of the impacts of rising temperatures and atmospheric CO_2 on human health is simply wrong. Numerous peer-reviewed studies demonstrate a warmer planet is beneficial to humanity, as warmer temperatures in all parts of the world lead to decreases in temperature-related mortality. The key findings of this chapter are presented in Figure 11.

The medical literature shows warmer temperatures and a smaller difference between daily high and low temperatures, as occurred during the twentieth and early twenty-first centuries, reduce mortality rates due to cardiovascular and respiratory disease and stroke occurrence.

Similarly, the research is quite clear that climate has exerted only a minimal influence on recent trends in vector-borne diseases such as malaria, dengue fever, and tick-borne diseases. Other factors, many of them related to economic and technological setbacks

Figure 10.
Key Findings: Aquatic Life

- Multiple studies from multiple ocean regions confirm ocean productivity tends to increase with temperature. Subjects of this research include phytoplankton and macroalgae, corals, crustaceans, and fish.

- Rising seawater temperature is conducive to enhanced coral calcification, leading some experts to forecast coral calcification will increase by about 35% beyond pre-industrial levels by 2100, and no extinction of coral reefs will occur in the future.

- Many aquatic species demonstrate the capability to adjust their individual critical thermal maximum (the upper temperature at which the onset of behavioral incapacitation occurs) upwards in response to temperature increases of the amount forecast by IPCC.

- Aquatic life has survived decadal, centennial, and millennial-scale climate oscillations that have persisted for millions of years. Evidence indicates they are well-equipped to adapt to forecasted increases in temperature, if necessary.

- Caution should be applied when interpreting results from laboratory-based studies of lower seawater pH levels. Such studies often are incapable, or fall far short, of mimicking conditions in the real world, and thus they frequently yield results quite different than what is observed in nature.

- Rising atmospheric CO_2 levels do not pose a significant threat to aquatic life. Many aquatic species have shown considerable tolerance to declining pH values predicted for the next few centuries, and many have demonstrated a likelihood of positive responses in empirical studies.

- The projected decline in ocean pH levels in the year 2100 (as compared to preindustrial times) may be significantly overstated, amounting to only half of the 0.4 value IPCC predicts.

- The natural variability of oceanic pH is often much greater than the change in pH levels forecast by IPCC.

- Natural fluctuations in pH may have a large impact on the development of resilience in marine populations, as heterogeneity in the environment with regard to pH and pCO_2 exposure may result in populations that are acclimatized to variable pH or extremes in pH.

- For those aquatic species showing negative responses to pH declines in experimental studies, there are adequate reasons to conclude such responses will be largely mitigated through phenotypic adaptation or evolution during the many decades to centuries the pH concentration is projected to fall.

Source: Chapter 6. "Aquatic Life," *Climate Change Reconsidered II: Biological Impacts* (Chicago, IL: The Heartland Institute, 2014).

Figure 11.
Key Findings: Human Health

- Warmer temperatures lead to a decrease in temperature-related mortality, including deaths associated with cardiovascular disease, respiratory disease, and strokes. The evidence of this benefit comes from research conducted in every major country of the world.

- In the United States the average person who died because of cold temperature exposure lost in excess of 10 years of potential life, whereas the average person who died because of hot temperature exposure likely lost no more than a few days or weeks of life.

- In the U.S., some 4,600 deaths are delayed each year as people move from cold northeastern states to warm southwestern states. Between 3 and 7% of the gains in longevity experienced over the past three decades was due simply to people moving to warmer states.

- Cold-related deaths are far more numerous than heat-related deaths in the United States, Europe, and almost all countries outside the tropics. Coronary and cerebral thrombosis account for about half of all cold-related mortality.

- Global warming is reducing the incidence of cardiovascular diseases related to low temperatures and wintry weather by a much greater degree than it increases the incidence of cardiovascular diseases associated with high temperatures and summer heat waves.

- A large body of scientific examination and research contradict the claim that malaria will expand across the globe and intensify as a result of CO_2-induced warming.

- Concerns over large increases in vector-borne diseases such as dengue as a result of rising temperatures are unfounded and unsupported by the scientific literature, as climatic indices are poor predictors for dengue disease.

- While temperature and climate largely determine the geographical distribution of ticks, they are not among the significant factors determining the incidence of tick-borne diseases.

- The ongoing rise in the air's CO_2 content is not only raising the productivity of Earth's common food plants but also significantly increasing the quantity and potency of the many health-promoting substances found in their tissues, which are the ultimate sources of sustenance for essentially all animals and humans.

- Atmospheric CO_2 enrichment positively impacts the production of numerous health-promoting substances found in medicinal or "health food" plants, and this phenomenon may have contributed to the increase in human life span that has occurred over the past century or so.

- There is little reason to expect any significant CO_2-induced increases in human-health-harming substances produced by plants as atmospheric CO_2 levels continue to rise.

Source: Chapter 7. "Human Health," *Climate Change Reconsidered II: Biological Impacts* (Chicago, IL: The Heartland Institute, 2014).

or progress and not to weather, are far more important in determining the transmission and prevalence of such diseases.

Finally, and perhaps surprisingly, IPCC entirely overlooks the positive effects of rising levels of atmospheric CO_2 on human health. Carbon dioxide fertilization has been shown to enhance certain health-promoting substances in plants, such as antioxidants, vitamin C, and fatty acids, and promote the growth of plants such as St. John's wort used for the treatment of a variety of illnesses. In this way, global warming portends great health benefits for humans. IPCC makes no mention of these benefits.

Conclusion

Climate Change Reconsidered II: Biological Impacts describes thousands of peer-reviewed scientific journal articles that do not support, and often flatly contradict, IPCC's pessimistic narrative of "death, injury, and disrupted livelihoods." The impact of rising temperatures and higher atmospheric CO_2 levels in the twentieth and early twenty-first centuries has not been anything like what IPCC would have us believe, and its forecasts differ wildly from those sound science would suggest.

Why is this research and perspective missing from IPCC's reports? NIPCC has been publishing volumes containing this research for five years—long enough, one would think, for the authors of IPCC's reports to have taken notice, if only to disagree. But the drafts of the Working Group II contribution to IPCC's *Fifth Assessment Report* suggest otherwise. Either IPCC's authors purposely ignore this research because it runs counter to their thesis that any human impact on climate must be bad and therefore stopped at any cost, or they are inept and have failed to conduct a proper and full scientific investigation of the pertinent literature. Either way, IPCC is misleading the scientific community, policymakers, and the general public. Because the stakes are high, this is a grave disservice.

How CO_2 enrichment has affected global food production and biospheric productivity is a matter of fact, not opinion. The evidence is overwhelming that it has and will continue to help plants thrive, leading to greater biodiversity, shrinking deserts, expanded habitat for wildlife, and more food for a growing human population. In sharp contrast to IPCC's pessimistic forecast of declining food production, NIPCC's authors say "a future warming of the climate coupled with rising atmospheric CO_2 levels will boost global agricultural production and help meet the food needs of the planet's growing population." They find "the positive direct effects of CO_2 on crop yields tend to overcome any negative effects associated with changed weather conditions."

Journalists, policymakers, and the interested public should demand to know why IPCC either hides or is silent about these truths.

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Authors, Contributors, and Reviewers of *CCR-II: Biological Impacts*

Lead Authors/Editors

Idso, Craig D.
Center for the Study of Carbon Dioxide and Global Change
USA

Idso, Sherwood B.
Center for the Study of Carbon Dioxide and Global Change
USA

Carter, Robert M.
Emeritus Fellow
Institute of Public Affairs
Australia

Singer, S. Fred
Science and Environmental Policy Project
Professor Emeritus, University of Virginia
USA

Contributors and Reviewers

Barnes, David J.
Australian Institute of Marine Science (retired)
Australia

Botkin, Daniel B.
University of Miami
University of California Santa Barbara
USA

Cloyd, Raymond A.
Kansas State University
USA

Crockford, Susan
University of Victoria, B.C.
Canada

Cui, Weihong
Chinese Academy of Sciences
China

DeGroot, Kees
Shell International (retired)
The Netherlands

Dillon, Robert G.
Physician
USA

Dunn, John Dale
Physician
USA

Ellestad, Ole Henrik
Research Council of Norway (retired)
Norway

Goldberg, Fred
Swedish Polar Institute
Sweden

Goldman, Barry
Australian Museum Lizard Island Research Station (retired)
Australia

Hoese, H. Dickson
Consulting Marine Biologist
USA

Jødal, Morten
Independent Scientist
Norway

Khandekar, Madhav
Environment Canada (retired)
Canada

Kutilek, Miroslav
Czech Technical University (emeritus)
Czech Republic

Leavitt, Steven W.
University of Arizona
Laboratory of Tree-Ring Research
USA

Maccabee, Howard
Doctors for Disaster Preparedness
USA

Marohasy, Jennifer
Central Queensland University
Australia

Ollier, Cliff
University of Western Australia
Australia

Petch, Jim
University of Manchester Trican
Manchester Metropolitan University (retired)
United Kingdom

Reginato, Robert J.
Agricultural Research Service
U.S. Department of Agriculture
USA

Reiter, Paul
Laboratoire Insectes et Maladies Infectieuses
Institut Pasteur
France

Segalstad, Tom
Resource and Environmental Geology
University of Oslo
Norway

Sharp, Gary
Independent Consultant
Center for Climate/
Ocean Resources Study
USA

Starck, Walter
Independent Marine Biologist
Australia

Stockwell, David
Central Queensland University
Australia

Taylor, Mitchell
Lakehead University
Canada

Weber, Gerd
Independent Meteorologist
Germany

Wilson, Bastow
University of Otago
New Zealand

Wust, Raphael
James Cook University
Australia

Editors

Karnick , S.T.
The Heartland Institute
USA

Bast, Diane Carol
The Heartland Institute
USA

Several additional reviewers wish to remain anonymous.

THE NONGOVERNMENTAL INTERNATIONAL PANEL ON CLIMATE CHANGE

The Nongovernmental International Panel on Climate Change (NIPCC) is an international network of scientists first convened in 2003 to examine the same climate data used by the United Nations-sponsored Intergovernmental Panel on Climate Change (IPCC). Unlike IPCC, NIPCC is not sponsored by governments and does not receive government funding. Whereas the mission of IPCC is to justify control of greenhouse gas emissions, NIPCC has no agenda other than discovering the truth about climate change.

CLIMATE CHANGE RECONSIDERED

Climate Change Reconsidered is a publication series produced by NIPCC and published by The Heartland Institute. Series editors Craig D. Idso, Robert M. Carter, and S. Fred Singer have assembled and oversee an international team of scholars devoted to producing a thorough and unbiased review of the extensive research on climate change. Four volumes were published prior to the present publication: *Nature, Not Human Activity, Rules the Climate* (2008), *Climate Change Reconsidered: The 2009 Report of the Nongovernmental International Panel on Climate Change (NIPCC)* (2009), *Climate Change Reconsidered: The 2011 Interim Report of the Nongovernmental International Panel on Climate Change (NIPCC)* (2011), and *Climate Change Reconsidered II: Physical Science* (2013). All are available for purchase from The Heartland Institute and for free online at www.climatechangereconsidered.org and www.nipccreport.org.

CCR II: BIOLOGICAL IMPACTS

The current report, *Climate Change Reconsidered II: Biological Impacts,* is the most comprehensive and up-to-date review of science on the impacts of climate change. This report combines the research and analysis of previous volumes in the series with new research published as recently as the first quarter of 2014 (well after the cut-off date for IPCC's *Fifth Assessment Report*). This volume tracks and critiques the expected 2014 report of IPCC's Working Group II on "Impacts, Adaptation, and Vulnerability." A third and final volume of CCR-II series, on "Human Welfare, Energy, and Policies," is being released concurrently with the present volume.

ABOUT THE COAUTHORS

Dr. Craig D. Idso is founder and chairman of the Center for the Study of Carbon Dioxide and Global Change. Since 1998, he has been the editor and chief contributor to the online magazine CO_2 Science. He is the author of several books, including *The Many Benefits of Atmospheric CO_2 Enrichment* (2011) and *CO_2 , Global Warming and Coral Reefs* (2009). He earned a Ph.D. in geography from Arizona State University (ASU), where he lectured in meteorology and was a faculty researcher in the Office of Climatology.

Dr. Sherwood B. Idso is president of the Center for the Study of Carbon Dioxide and Global Change. Previously he was a Research Physicist with the U.S. Department of Agriculture's Agricultural Research Service at the U.S. Water Conservation Laboratory in Phoenix, Arizona. He is the author or co-author of over 500 scientific publications including the books *Carbon Dioxide: Friend or Foe?* (1982) and *Carbon Dioxide and Global Change: Earth in Transition* (1989). He served as an Adjunct Professor in the Departments of Geology, Geography, and Botany and Microbiology at Arizona State University. He earned a Ph.D. in soil science from the University of Minnesota.

Dr. Robert M. Carter is a stratigrapher and marine geologist with degrees from the University of Otago (New Zealand) and University of Cambridge (England). He is the author of *Climate: The Counter Consensus* (2010) and *Taxing Air: Facts and Fallacies About Climate Change* (2013). Carter's professional service includes terms as head of the Geology Department, James Cook University, chairman of the Earth Sciences Panel of the Australian Research Council, chairman of the national Marine Science and Technologies Committee, and director of the Australian Office of the Ocean Drilling Program. He is currently an Emeritus Fellow of the Institute of Public Affairs (Melbourne).

Dr. S. Fred Singer is one of the most distinguished atmospheric physicists in the U.S. He established and served as the first director of the U.S. Weather Satellite Service, now part of the National Oceanic and Atmospheric Administration (NOAA), and earned a U.S. Department of Commerce Gold Medal Award for his technical leadership. He is coauthor, with Dennis T. Avery, of *Unstoppable Global Warming Every 1,500 Years* (2007, second ed. 2008) and many other books. Dr. Singer served as professor of environmental sciences at the University of Virginia, Charlottesville, VA (1971-94), and is founder and chairman of the nonprofit Science and Environmental Policy Project. He earned a Ph.D. in physics from Princeton University.

One South Wacker Drive #2740
Chicago, IL 60606
www.heartland.org