Congressional Testimony
on the IPBES
(Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services)
Assessment of Global Biodiversity Loss

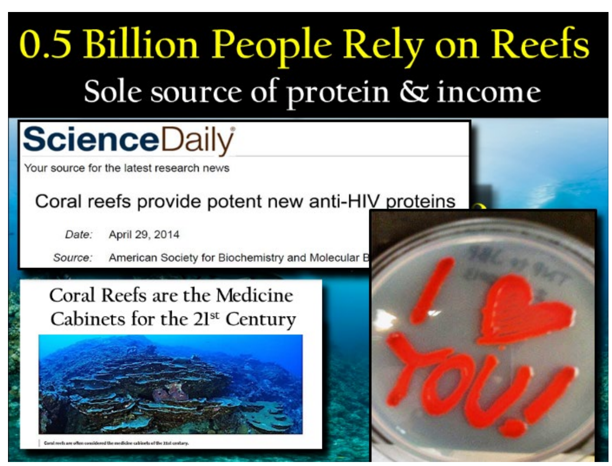
Dr. James W. Porter
Josiah Meigs Distinguished Professor of Ecology, *Emeritus*
Odum School of Ecology
University of Georgia
Athens, GA 20602
jporter@uga.edu

U.S. House of Representatives *Committee on Science, Space, & Technology*
Rayburn House Office Building; Room 2321
Tuesday-4-June-2019; 10:00 AM
Congresswoman, Eddie Bernice Johnson, (Texas) Chair

This hearing has been called to addresses the continuation of diverse life on Earth and the integrity of the life-support systems that diverse ecosystems provide to everyone. The current IPBES assessment suggests that of the estimated 8.7 million species on Earth, 1 million are facing extinction. In addition, the magnitude and pace of these extinctions is likely to accelerate unless we put in place sweeping and sustained actions to prevent these catastrophic losses.

In this testimony, I will show that the global losses detailed in the IPBES Report are already occurring on coral reefs. Further, I will present evidence demonstrating that the risks outlined in their assessment will, almost inevitably, increase for coral reefs in the very near future.

Although coral reefs are tropical shallow-water marine habitats and cover less than 1% of the planet, they have an outsized importance to both human beings and the natural world.



Coral reefs generate $9.9 trillion U.S.D. annually. A half billion people rely on them for their protein and as a source of income.

The following gives a thumbnail sketch of the importance of coral reefs to humankind:

- 94 of the world's sovereign nations (roughly half of all countries) have coral reefs within their territorial boundaries.
- Most of these are developing countries desperately in need of the goods and services that coral reefs provide.
- 500 million people are dependent on coral reefs as their primary source of protein and income.
- Coral reefs generate $9.9 trillion U.S.D. / yr. (roughly the GDP of Switzerland).
- Coral reefs generate $29.8 billion/yr. in Hawaii and Florida.
- On the Great Barrier Reef, 90,000 full-time jobs are directly dependent on coral reefs.
- Coral reefs have proven to be a marine pharmacopeia, yielding new drugs that reduce the risk of heart attacks in older Americans, cure certain kinds of cancer, and that kill the A.I.D.S. virus more effectively than AZT.

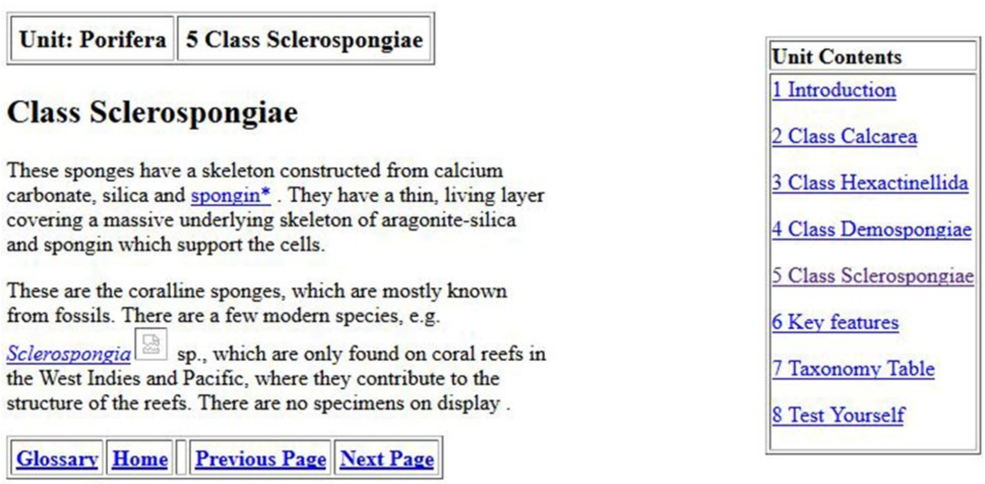
In addition to their importance to human society, coral reefs are also of outsized importance to the history of life on Earth:

- Coral reefs are the oldest, most productive, and most biologically diverse of all marine communities.
- Coral reefs are the only living things that can be seen from outer space.
- 25% of all described marine species of plants and animals live exclusively on coral reefs.
- With increased taxonomic studies, that percentage would rise dramatically.
- However, with the predicted near-term extinction of coral reefs world-wide, we may never know that number precisely. In this respect, Dr. E.O. Wilson's comment seems especially apropos:

Most species will probably be described from a single museum specimen, long after the species has gone extinct.

E.O. Wilson, Harvard University

- Coral reefs are the most productive of all marine communities, generating close to 2,000 dry grams-carbon / m^2 / yr.
- Due to their biological diversity, especially at higher taxonomic levels, coral reefs are by far the most diverse environments on Earth. For instance, while tropical rainforests harbor only 8 animal phyla, coral reefs sport 30.
- Most importantly, recent studies of the history of life on Earth show that 85% of the time that a new Family, Order, Class, or Phylum appears on Earth, it does so first on coral reefs. This makes coral reefs both a *Cradle* of evolution for radically new life forms and a *Museum* for their ability to retain species that evolve there.
- The destruction of coral reefs therefore does not just threaten global species diversity, but also the fundamental ability of life to generate new life.
- A specific example of this comes from the marine sponges (Phylum Porifera). Class Sclerospongiae, one of the 5 classes of sponges. It has the unique ability to form its skeleton out of either limestone (calcium) or glass (silicone).
- This Class is exclusively shallow-water, tropical marine.
- Although the last Class of organisms (in any phylum) went extinct more than 500 million years ago, with the destruction of coral reefs, we could lose this Class within the next 50 years.



Unit: Porifera	5 Class Sclerospongiae

Class Sclerospongiae

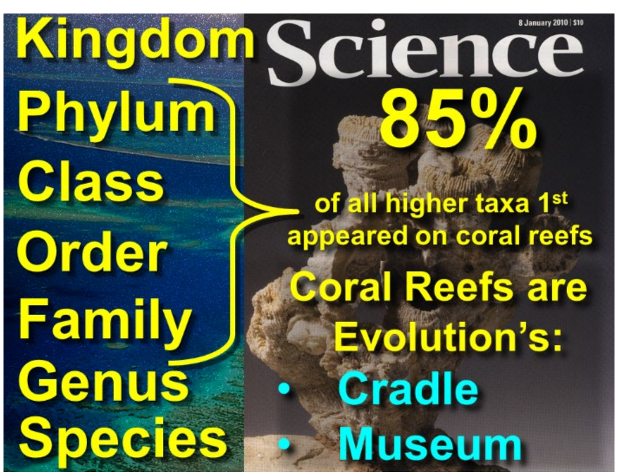
These sponges have a skeleton constructed from calcium carbonate, silica and spongin* . They have a thin, living layer covering a massive underlying skeleton of aragonite-silica and spongin which support the cells.

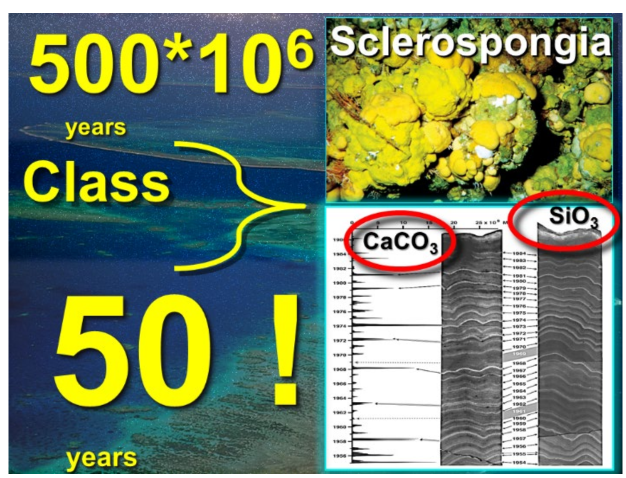
These are the coralline sponges, which are mostly known from fossils. There are a few modern species, e.g. *Sclerospongia* sp., which are only found on coral reefs in the West Indies and Pacific, where they contribute to the structure of the reefs. There are no specimens on display .

Glossary | Home | Previous Page | Next Page

Unit Contents

1 Introduction
2 Class Calcarea
3 Class Hexactinellida
4 Class Demospongiae
5 Class Sclerospongiae
6 Key features
7 Taxonomy Table
8 Test Yourself

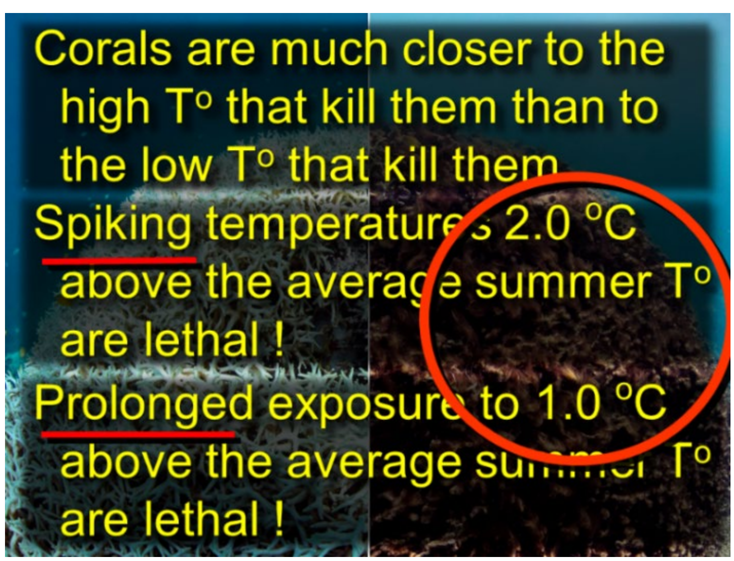




All of the factors listed by the IPBES as threats to the survival of terrestrial species world-wide also pertain, in varying degrees, to coral reef species.

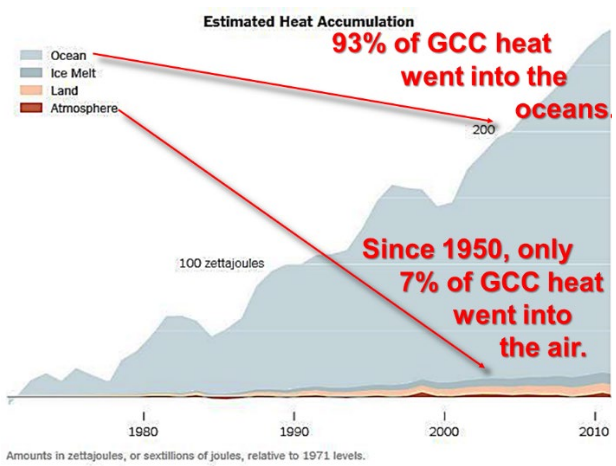
- The destruction of coastal zone habitats (including mangroves and sea grass beds) occurs by rampant shore-line development.
- Overfishing on coral reefs, especially of large fish and top predators, such as sharks, occurs in many tropical countries.
- Pollution, both:
    - Large and small plastic particles on beaches and in many central oceanic gyres.
    - Coastal-zone eutrophication driven by waste-water from coastal communities and nearby agricultural lands (especially fertilizer-intensive sugar cane fields).
- Invasive species, such as the Indo-Pacific lion fish that were released into the tropical waters of South Florida are now found everywhere throughout the Caribbean.

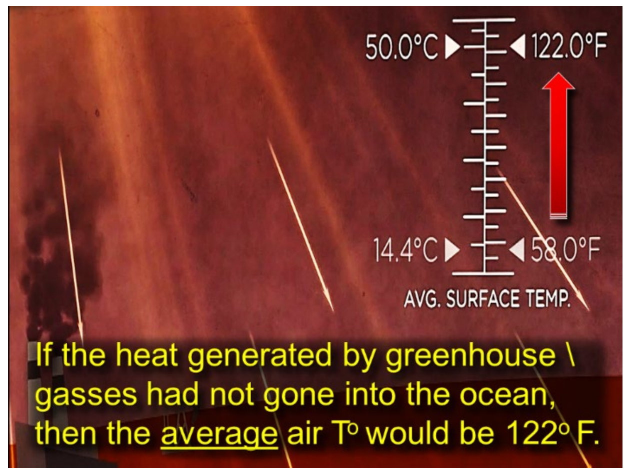
By far the biggest threat to coral reefs, however, comes not from these ancillary stressors, but from rising ocean temperatures. Corals already live close to their thermal tolerance limits. The addition of just 2° C will kill them.



Due to burning fossil fuels (coal, oil, and natural gas), global temperatures are rising rapidly, especially in the oceans. The reason for this can be summarized as follows:

- 93% of the heat generated by green-house gases is "stored" in the ocean, not in the air.
- This is why water temperatures have risen so quickly.
- If it weren't for the oceans' ability to absorb greenhouse-gas generated global-warming, the average temperature of our planet would be 122ºF.
- The oceans are 'saving' us (temporarily), but at an immediate cost to coral reefs.





An irony is that these tropical organisms are much closer to the high temperatures that kill them than to the low temperatures that kill them. They are like orchids, you can cool them down a little and they will survive, but you cannot heat them up:

- In tropical waters, corals live within 2ºC of the high temperatures that kill them.
- Elevated temperatures cause corals to lose the symbiotic algae which live inside them.
- These symbionts photosynthesize and provide corals with food.
- When corals lose their symbiotic algae, they starve to death.
- These symbiotic algae also give corals their color (the colors of coral are from plant pigments, not animal pigments).
- When the algae die, you can see through the clear animal tissue to its white lime-stone skeleton underneath, hence the term "coral bleaching."

The irrefutable science behind these observations demonstrates that:

- Global warming will cause tropical seas to rise above this 2ºC threshold by 2040 – 2050.
- Even before then, short-term temperature spiking episodes (which also cause coral bleaching) are expected (and have already been observed).
- Back-to-back years of high temperatures cause back-to-back bleaching events, as occurred recently on the Great Barrier Reef in Australia (GBR).
- These events are especially devastating because, even if a weakened coral survives the first bleaching episode, there is no time to recover its strength to survive the second.

Coral “bleaching” (the loss of beneficial symbiotic algae) caused by anthropogenic global warming.

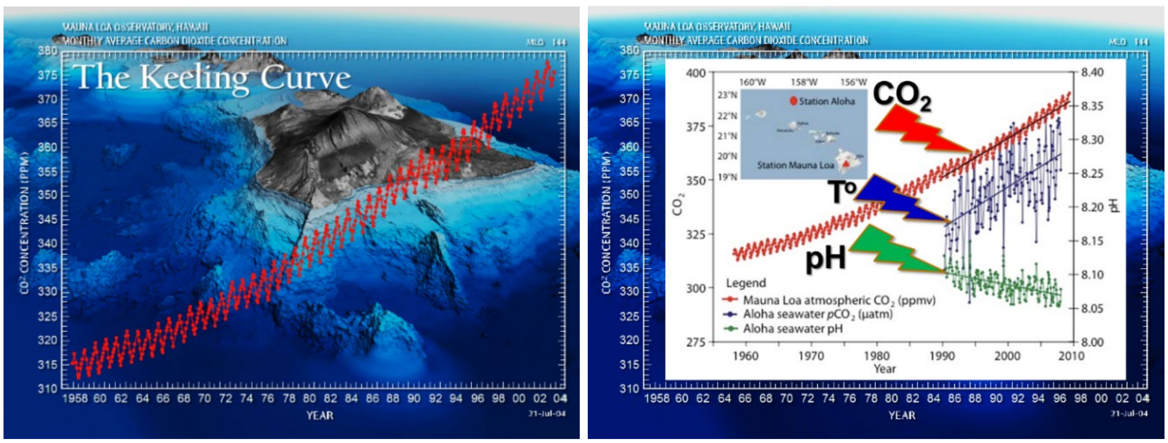
This apocalypse is neither a distant peril nor a hypothetical threat to coral reefs. It is here; it is here now:

- 66% of all GBR corals died within the last two years.
- World-wide, 50% of all corals have died in the last three decades, mostly from climate change and global warming.
- Coral reefs world-wide are not recovering.
- As a result of climate change, most coral reefs are predicted to be gone by 2040-2050, and with them the vast majority of species that constitute their extraordinary bio-diversity.
- Current rates of planetary warming are considered to be too rapid for coral adaptation.
- Even with the benefit of “assisted evolution,” whereby we attempt to create coral populations with elevated temperature-tolerances, the scale of the problem and the extremely high temperatures expected under any business-as-usual CO_2 emissions scenario, are considered to be too great for coral survival.

Elevated CO_2 levels affect the ocean in at least two physico-chemical ways:

- Rising temperatures (global warming)
- Falling *pH* (ocean acidification)

These two ocean modifiers have been referred to as the “Evil Twins” of climate change. Whereas global warming causes coral bleaching by killing the symbiotic algae, the solution of CO_2 into oceanic waters causes the *pH* to fall as the ocean becomes more acidic. This future threat is of dire concern because, depending on the CO_2 level, these acidic waters will either slow or prevent entirely the deposition of coral limestone skeletons. This phenomenon is analogous to the commonly understood etching effect of acid rain on limestone tombstones.



Both atmospheric and marine CO_2 levels have been monitored in Hawaii. All measurements demonstrate, that as anthropogenic CO_2 levels rise, air and water temperatures also rise, and oceanic pH falls.

Both global warming and ocean acidification are expected to destroy coral reefs as we know them by the end of this century. Caitlin SeaView[@]

I illustrate the extent of this global problem with two examples, one from the Florida Keys, the other from Discovery Bay, Jamaica.

Florida has lost half of all its living coral since the early1980s. These losses are continuing.

One example from Eastern Dry Rock Reef off of Key West can be seen below. These kinds of losses on shallow water reefs are common throughout the Florida Keys.

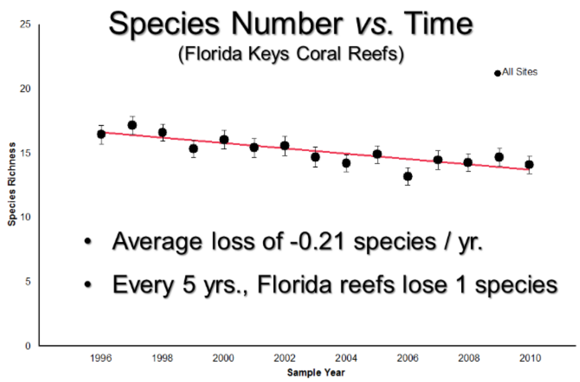
Before **1994** Dry Rocks Reef Key West, FL – J.W. Porter

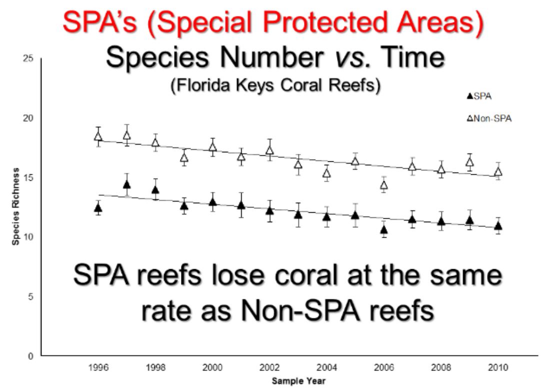
After **2004** Dry Rocks Reef Key West, FL – J.W. Porter

I addition to coral cover, reefs of the Florida Keys are also loosing species rapidly.

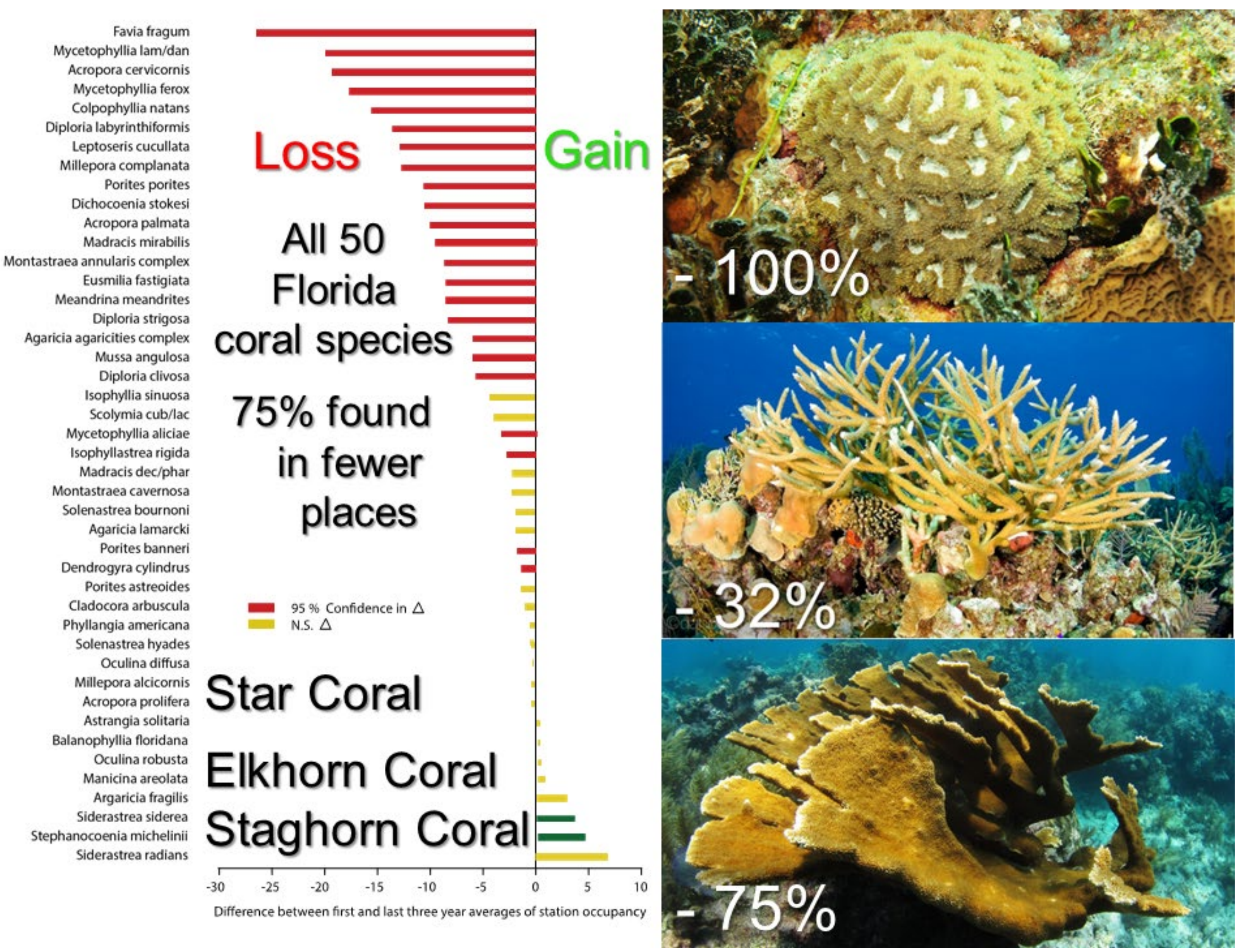
- With 43 reefs investigated, on average, Florida reefs lose 0.21 coral species per year.
- That translates to one species lost every 5 years.
- Alarmingly, this rate of species loss is the same both inside the NOAA Marine Sanctuary Special Protected Areas and outside these carefully protected and carefully monitored no-take zones (see graphs below).
- 75% of all coral species in the Florida Keys are now found in fewer places than they were at the beginning of the *E.P.A. Coral Reef Evaluation and Monitoring Program*, which started in 1994.
- One coral species, *Isophyllastrea rigida* has now gone extinct in the Florida Keys.

- Once among the commonest corals in the Caribbean, the iconic branching Elk Horn and Stag Horn corals have declined so much that they have been added to the Endangered Species List.





Florida reefs lose on average 1 species every 5 years, both inside and outside the NOAA National Marine Sanctuary Special Protected Areas – J.W. Porter and M. Meyers



Similar losses occur throughout the Caribbean, as illustrated here with this pair of "before & after" photographs taken on shallow-water reefs in Discovery Bay, Jamaica. A combination of bleaching and hurricanes has degraded and converted vast regions along the north coast of Jamaica from coral reefs with high coral cover and high species diversity to rubble zones with low coral cover and low diversity.

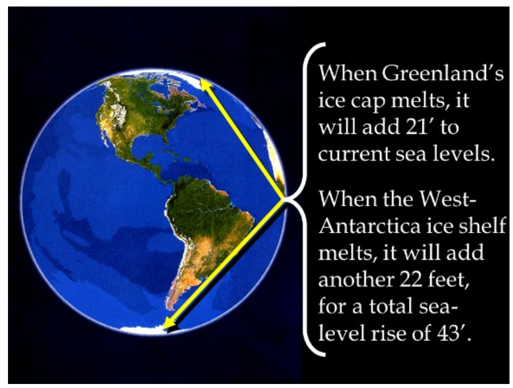
Before **1976** Discovery Bay, Jamaica

After 1986 Discovery Bay, Jamaica

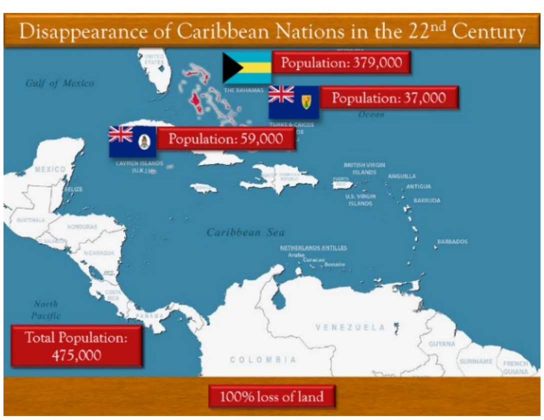
Finally, elevated CO_2 levels in the Earth's atmosphere will affect the ocean in at least one additional way. It will increase its physical size, causing:

- Sea Level rise, due to:
  - Glacial melt and
  - Thermal expansion

In tropical regions, sea-level rise will have devastating effects on coastal fishing and tourist communities that have grown up near coral reefs. Currently the "average-case" IPCC model predicts that sea levels will rise approximately 2 m by the end of this century. "Worst-case" models, however (which fit the data much better than the average-case models), put this S.L.R. value closer to 3 m. Regardless of which model is right, projecting sea level rise only to 2100 underplays the fact that by 2100, sea level will be rising nearly exponentially. Increases after 2100 will be much faster than before 2100.



Given that sovereign nations like The Bahamas, Turks & Caicos, and the Cayman Islands are comprised exclusively of low-islands (and are therefore without mountainous interiors like Jamaica or Cuba), their existence is threatened by sea-level rise. These three island nations have a combined population of 475,000, all of whom are likely to become climate refugees sometime during the 22nd Century. Pacific island states like Kiribati are already beginning to transfer their population to nearby New Zealand. Other countries in the Caribbean, as well as coastal regions in Florida and elsewhere around the U.S. likewise face a diminution of their coast lines and a significant loss of their land areas (see maps below).



The IPBES report is an alarm bell. It tells us that to save the biological heritage of the Earth and the Ecosystem Services they provide, humankind must change its extractive and exploitative relationship to the natural world. We must stop maligning it and start preserving it.

For coral reefs, programs that reduce coastal-zone pollution are needed in addition to programs that reduce greenhouse gas emissions. We are in a race against time. We are losing.

I was asked to say something about what this House Committee could and should do in response to the IPBES report. All of the agencies you oversee, such as NSF, EPA, NOAA, NASA, *etc.*, should be tasked (and funded!) to undertake broad-scale programs to address the planet's impending biodiversity crisis.

In addition, I would like to suggest that perhaps the most important thing you could do would not cost anything. I recommend that each Member of the *Committee on Science, Space, and Technology* speak to at least one additional Member of Congress about what you have learned today. Tell them that the irrefutable evidence, from both land and sea, is that humankind is destroying species and ecosystems at an unsustainable rate. In addition to wreaking havoc on the natural world, these actions threaten our way of life, our civilization, and, potentially, even our own existence. The full weight of the U.S. government is necessary to address this planetary threat.

Biography

James W. Porter, Ph.D.
Josiah Meigs Professor of Ecology, *Emeritus*
Odum School of Ecology
University of Georgia, Athens, GA
jporter@uga.edu

James W. Porter is the Josiah Meigs Distinguished Professor of Ecology, *Emeritus* at the University of Georgia. Dr. Porter received both his Bachelor's and Ph.D. degrees from Yale.

He has testified before Congress two times about the effects of climate change on coral reefs. His current research on coral health is funded by the *NIH Ecology of Infectious Disease Program*.

In 2005 he received the *Eugene P. Odum Award* for environmental education from the *Ecological Society of America*, and in 2006, he was elected President of *Sigma Xi*, the Scientific Honor Society with more than 160,000 members worldwide, including all living *Nobel Laureates*. In 2019 he received the *Coral Reef Society*'s top *Eminence in Research Award.*

Dr. Porter's award winning photographs have appeared in *Life Magazine* and the *New York Times*. His work has been featured on the *ABC World News*, *NBC Nightly News,* and *CNN*.

His documentary film, *Chasing Coral*, to which he contributed as the Chief Scientific Advisor and a Principal Cast Member, won the *Audience Choice Award* at the *2017 Sundance Film Festival*, and then went on to win a *2017 Peabody Award* and the *2017 Emmy* for *Best Nature Documentary*.

CURRICULUM VITAE

James W. Porter, Ph.D.

Josiah Meigs Distinguished Professor of Ecology, *Emeritus*

Odum School of Ecology
University of Georgia / Athens, GA 30602
(706) 207-5177 (Office); E-mail: jporter@uga.edu

PERSONAL INFORMATION

Born: 5-October-1946
Wife: Karen G. Porter, Ph.D., Professor of Ecology, University of Georgia

RESEARCH AND SCIENTIFIC INTERESTS

Population and disease ecology, ecology of coral reefs, biological and historical origins of species diversity, biogeography, systematics of the scleractinian corals, marine consequences of global climate change; fates and consequences of toxic residue from underwater unexploded ordnance (UWUXO).

EDUCATIONAL EXPERIENCE

B.S. (Biology) Yale College, New Haven, CT, 1965-1969
Ph.D. (Biology) Yale University, New Haven, CT, 1969-1973

EMPLOYMENT EXPERIENCE

Member, Technical Advisory Board, International Dialogue on Underwater Munitions (2013 –)
Associate Dean, Odum School of Ecology (2007 - 2011)
Associate Director for Academic Affairs, Institute of Ecology (1994 - 1997)
Graduate Coordinator, Ecology Degree Program, University of Georgia (1992 - 1997)
Professor of Ecology & Marine Sciences, University of Georgia, Athens, GA (1993 - 2016)
Professor of Zoology (1985 - 1993), University of Georgia, Athens, GA 30602
Curator of Invertebrates (1985 - 1995), University of Georgia Museum of Natural History
Coordinator, University of Georgia Alumnae Foundation Fellows Program (1984 - 1987)
Biologist, Environmental Protection Agency, Gulf Breeze, FL (1980)
Associate Professor of Zoology (1977 - 1984), University of Georgia, Athens, GA 30602
Assistant Professor (1973 - 1977), School of Natural Resources, University of Michigan, Ann Arbor, MI 48109
Smithsonian Pre-Doctoral Fellow (1971-1972), Smithsonian Trop. Res. Inst., Panama
Curatorial Assistant, Peabody Museum of Natural History, Yale University (1965-1969)

FELLOWSHIPS, HONORS, AND SPECIAL AWARDS

National Science Foundation Undergraduate Research Participation Award (1968)
Honors in Biology, Yale College (1969)
U.S. National Museum & Smithsonian Tropical Research Institute, Pre-Doctoral Fellowship (1972-1973)
National Science Foundation Doctoral Dissertation Improvement Award (1972-1973)
John Spangler Nicolas Outstanding Doctoral Dissertation Award, Yale University (1973)
Editor, *Ecology* and *Ecological Monographs* (1975-1980)

Woods Hole Marine Ecology Staff (Summers 1977 - 1979; 1986 - 1988)
Elected to the *American Society of Naturalists* (1978)
Creative Research Award, University of Georgia (1983)
Elected *Fellow of the American Association Advancement Science* (1983)
Outstanding Educator Award, *Gama Beta Phi National Honor Society* (1984)
Faculty Excellence Award, *Golden Key Honor Society* (1985)
Sandy Beaver Teaching Award (1988), University of Georgia
Congressional Testimony, Joint Session House of Representatives and Senate (1992)
Congressional Testimony, House of Representatives (1998)
Congressional Testimony, House of Representatives (2004)
University of Georgia *Josiah Meigs Excellence in Teaching Award* (2004)
Josiah Meigs Distinguished Professor of Ecology (2004)
Eugene P Odum Award, Ecological Society of America (2005)
President-Elect, *Sigma Xi* (2006)
President, *Sigma Xi* (2007)
University of Georgia 2007 *Student Government Association Outstanding Professor Award*
2017 Sundance Film Festival; Audience Choice Award for *Chasing Coral*
2018 Peabody Award for *Chasing Coral*
2018 Emmy Award (Best Documentary) for *Chasing Coral*
Excellence in Research Award; International Society for Reef Studies, 2018

EDITORIAL BOARDS

Editor, *Ecology* and *Ecological Monographs* (1975-1980)

SYMPOSIUM ORGANIZER

Fifth International Coral Reef Congress, Papeete, Tahiti (1985)
Eleventh International Coral Reef Symposium Boca Raton, Florida (2009)

MAJOR NSF OR NOAA FUNDED SCIENTIFIC EXPEDITIONS

Chief Scientist, *Johnson-Sea-Link Submarine*, Tongue of the Ocean, Bahama Is. (1972)
Staff Scientist, *Hydrolab* Mission, Bahama Islands (1974)
Staff Scientist, *R.V. Alpha Helix*, Clarion Island, Eastern Tropical Pacific (1974)
Staff Scientist, *R.V. Alpha Helix*, Visayan Sea Expedition, Philippines (1975)
Staff Scientist, *R.V. Ackeron*, Great Barrier Reef Expedition, Australia (1981)
Staff Scientist, *Hydrolab* Mission, St. Croix, U.S. Virgin Islands (1982)
Chief Scientist, *R.V. Sea Hawk*, Fore-Reef Expedition, Discovery Bay, Jamaica (1983)
Staff Scientist, *Hydrolab* Mission, St. Croix, U.S. Virgin Islands (1985)
Chief Scientist, *Aquarius* Mission 88-3, St. Croix, U.S. Virgin Islands (1988)
Chief Scientist, U.S. National Park Service, Tracks I & II Coral Reef Studies (1989 - 1993)
Staff Scientist, Coral Reef Biodiversity Project, Guam (1992)
Chief Scientist, EPA Coral Reef Recovery Study, Charleston, SC (1992)
Chief Scientist, EPA Long-Term Research on Coral Reef Health & Survival, Florid Keys (1998 – 2015)

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Santavy, D.L., E. Mueller, E.C. Peters, L. MacLauglin, J.W. Porter, K.L. Patterson, and J. Campbell. 2001. Quantitative assessment of coral diseases in the Florida Keys: Strategy and methodology. *Hydrobiologia* **460:**25-38.

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SELECTED GRANTS

NSF OCE-81-10918 (1981). Long term analysis of benthic population and community dynamics on a coral reef. J.W. Porter, PI/PD, 2 yrs., $158,587.

NSF OCE-83-00623 (1983). Temporary commensalism between benthic macro-algae and gorgonian corals. J.W. Porter, PI/PD, Co-PI: C. Slocum. 2 yrs., $23,000.

NSF OCE-87-18256 (1987). Nutrient sources and sufficiency for symbiotic zooxanthellae. J.W. Porter, PI/PD, 3 yrs., $24,526.

NSF OCE-88-05761 (1988). "Bleaching" in Caribbean reef corals. J.W. Porter, PI/PD, 1 yr., $20,000.

NSF OCE-93-18503 (1993). The physiology of sclerochronology: Mechanisms and variation in formation of the high density band in the massive coral *Montastraea annularis*. J.W. Porter, PI/PD, 3 yrs., $111,350.

NOAA Porter, J.W. and W. Alevizon. Design and implementation of a coral reef marine protected area corridor in the Bahamas. NOAA International Programs (01/JAN/03 to 31/DEC/2004) $15,000.

EPA Porter, J.W., E. Lipp, and K.P. Sutherland. 2004. The etiology and distribution of coral disease in the Florida Keys. U.S. Environmental Protection Agency (01/JAN/04 to 31/DEC/05) $208,000.

CPR Porter, J.W. (P.I./P.D.) 2005. The physical and chemical effects of naval bombardment on Vieques, P.R. coral reefs. Commonwealth of Puerto Rico (01/JUN/03 to 31/DEC/05) $15,000.

Entrix Fitt. W.K. (P.I./ P.D.) and J.W. Porter (co-P.I.) 2010-2012. Differential response to bleaching and oil exposure of reef-building corals in the Florida Keys. (2010 to 2012).

EPA 21-95 (1995 - 2011). Long-term monitoring of coral reef survival in the Florida Keys. J.W. Porter, PI/PD, 16 yrs., $1,750,000.

UGA Porter, JW. 2008-2017. Butterflies of Monteverde, Costa Rica. (01/Jun/08 to 31/Dec/17) $11,000.

NIH/NSF Porter, J.W. (P.I./P.D.) 2010 – 2017. The Ecology of a Reverse Zoonosis: Human-Environment Interactions in the Transmission, Persistence, and Virulence of White Pox Disease in Elkhorn Coral (Oct-2010 to October-2017) $2,300,000.

Reef Ball Foundation Porter, J.W. (P.I.P.D) The Premier of *Chasing Coral* in Athens, GA (Jun-2017 – Jun-2018) $15,000.

Reef Ball Foundation Porter, J.W. (P.I.P.D) Archival Imagery from the Discovery Bay Laboratory, Discovery Bay, Jamaica (Jan-2018 – Dec-2019) $72,000.

CURRENT GRANTS

Kirbo Foundation Porter, J.W. (P.I.P.D.) Archival Imagery of Coral Reefs at Discovery Bay, Jamaica (1976 – 1986). (Jan-2018 – Dec-2019) $87,000.

PENDING GRANTS *(under review)*

NIH Porter, J.W. (P.I./P.D.) 2018 – 2023. The Epigenetic and Public Health Consequences of Munitions-Exposure on Vieques, Puerto Rico (Jan-2019 to Dec-2023) $3,327,000.

NSF Porter, J.W. (P.I./P.D.) 2018 – 2021. Ecological Responses to Environmental Change: The Development of Image Analysis Tools to Measure Coral Reef Rugosity and Structural Integrity. (July-2019 – June-2022) $179,300

GRADUATE TRAINING & ADVISING

33 Ph.D. Students
9 Master's Students
2 Postdoctoral Fellows

DIVING EXPERIENCE

SCUBA Certified, 1965; NAUI/PADI Certified, 1977
Nitrox / Heliox / Mixced-Gas Certified, 1983
NOAA Working Diver, 1984; NOAA Saturation Certified in both *HydroLab* (1974) and *Aquarius* (1988)
AAUS – UGA (*American Association of Underwater Scientists*) Certified, 1999 – 2019
>5,000 Research Scuba Dives