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LEAFY SURVIVAL DEPENDS ON TEAM EFFORT

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It is now clear that climate change is a critical threat to marine conservation. Major political changes and shifts in attitude toward the environment are needed to avert a global marine catastrophe. It is also clear that many governments, their supporting institutions, and some industries have suppressed evidence of global warming. Unfortunately, these interests now champion a suite of solutions to lessen the effects of excessive energy use; emphasising disreputable technologies such as nuclear energy, and expensive 'fixes' including locking up of carbon dioxide from fossil fuel fired power stations.

In response to this crisis entrenched interests have encouraged a concerted media campaign to trivialise as second best environmentally sustainable solutions. Demonstrated reduction of energy use, through both increased energy efficiency and reduced consumption, are among the most effective ways to reduce carbon dioxide emissions. The most promising methods to provide sustainable means for the generation of energy are renewable sources including solar, wind, and geothermal generation.

Global warming has the potential to extinguish much life on earth, and the President of the American Association for the Advancement of Science, John P. Holdren, urged scientists to devote themselves to environmental and social issues. "Scientists and engineers ... must join with political and business leaders in a concerted search for solutions," Holdren said, "without swift and urgent action the problems could spiral toward disastrous, permanent changes for all of life on Earth." (1)



Large numbers of crabs were driven toward the shoreline by the lack of oxygen in the water caused by climate shifts (source, the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO), Oregon State University).

The effects of climate change in many terrestrial and marine ecosystems have already been demonstrated at a global level. Scientific evidence shows that ecological changes in structure of systems the distribution of plants and animals are occurring in all well-studied marine, freshwater, and terrestrial groups. These changes are as predicted from global warming models and are linked to local or regional climate change. Observed genetic shifts modulate local effects of climate change, but there is little evidence that they will mitigate negative effects at the species level. Overall the genetic adaptation of affected species has not promised their survival with predicted climatic changes. (2)

With climate change predator prey and plant insect relationships are particularly affected. For instance beetles encouraged by global warming are killing vast areas of forest in the tundra. Range-restricted species, particularly polar and mountaintop species, show severe range contractions and have been the first groups in which entire species have gone extinct due to recent climate change. In Australia among others several frog species have declined or gone extinct in the eastern highlands because of receding snow lines. (2)

Among marine systems those at climatic or physiological extremes including tropical coral reefs or polar systems have been most negatively affected. Unfortunately, however increasing signs of climate change on temperate marine systems are also being shown. (2)



There were extensive die-offs of crabs and other marine life throughout the region source, the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO), Oregon State University).

Recently there have been several disturbing affects of increase atmospheric carbon dioxide and global warming on the marine environment. Krill numbers, the backbone of the Antarctic food chain, have dramatically declined. Large scale devastation of marine life due to changes in ocean currents causing nutrient starvation or lack of oxygen on the ocean bottom have occurred in the USA, Africa, and South America. Most disturbing of all increased acidity of ocean waters threatens the life of organisms dependent on calcium skeletons including corals and plankton essential to marine food chains.

In 2004 studies showed that populations of krill, the shrimp cocktail in the Antarctic that feeds whales, seals and penguins had declined 80 per cent over the last 25 years. Antarctic krill are one of the most important foods for fish, penguins, seals and whales. To the detriment of krill global warming has reduced ice cover and increased water temperatures surrounding Antarctica. There have been dramatic declines in the population of some populations of penguins and seals as a result (BASPO 2004).

Changes to ocean currents are causing 'dead zones' in cool temperate oceans and affecting demersal - bottom dwelling - organisms off the coast of Oregon, USA, and increasingly in other regions. The coastal region of Oregon normally provides a rich harvest fish and crabs. (4)

Oregon's dead zone was first identified in 2002. During the mass deaths of marine life the seafloor oxygen levels are 10 to 30 times lower than normal, and sometimes close to zero. The researchers say these hypoxic, low oxygen, events are connected to upwelling of cold, nutrient rich water to the ocean surface. Normally, upwelling provides valuable nutrients critical for marine life and for fisheries. During the hypoxic events, the upwelled water is coming colder, more

nutrient rich and lower in oxygen than usual. Dead zones are created through changes in wind patterns which can disrupt the currents and the balance between productive food webs. Extreme and unusual fluctuations in wind patterns and ocean currents are consistent with the predicted impacts of climate change caused by increased carbon dioxide. (4)

None of the previous dead zones, recorded since 2002, were as extensive as the event in 2004. Changes in strong upwelling winds allowed a low oxygen pool of deep water to build up and the dying plankton further reduced oxygen levels on the ocean bottom. The massive phytoplankton bloom from excessive nutrients that contributed to this dead zone turned large areas of the ocean dirty chocolate brown. One of the areas affected is a rocky reef not far from Yachats, Oregon. Ordinarily this is prime rockfish habitat, inhabited by black rockfish, ling cod, kelp greenling, and canary rockfish. The seafloor normally hosts large populations of Dungeness crab, sea stars, sea anemones and other marine life. (4)

"Seeing so much carnage on the video screens [in 2004] was shocking and depressing," said Dr. Jane Lubchenco professor of biology and zoology at Oregon State University, a past president of the American Association for the Advancement of Science. "We saw a crab graveyard and no fish the entire day," she said, "thousands and thousands of dead crab and molts were littering the ocean floor, many sea stars were dead, and the fish have either left the area or have died and been washed away. It's hard to tell just how much mortality, year after year, these systems are going to be able to take." (4)



This images was taken during a November 2000 of the edge of the Antarctic ice sheet in excursion to B-15A and C-16 the National Science Foundation (Josh Landis, National Science Foundation).

Large areas of the Antarctic ice shelves have collapsing as warmer ocean waters create melts.

This extreme cycling of the marine system is similar to the weather extremes on land with droughts alternating with floods. It appears that global warming is driving the climate extremes by throwing previously predictable seasonal winds out of kilter. The first disaster occurred when a nutrient-rich ocean current that normally appears in spring was delayed by a month. This led to a loss of phytoplankton the vital food base upon which larger animals depend. Salmon starved and then other predators, including many sea birds starved and died. (4)

In 2007 unprecedented changes to ocean currents are having a devastating effect on finely balanced marine ecosystems, leading to the death of huge numbers of sea animals including crabs, salmon and thousands of birds. After the starvation event the west coast current came back with a vengeance, producing an upwelling of nutrient-rich water twice as strong as usual. Phytoplankton bloomed to levels not seen before, turning the sea to green-brown soup. They then died and sank, causing oxygen levels in the water to plummet virtually to zero. The result was a dead zone in which no fish, crabs, worms or other large marine life could survive.

Scientists conducting a submarine survey found dead crabs and marine worms scattered across the ocean floor, and no sign of any fish. The knock-on effects were once again disastrous for sea birds which relied on the sea creatures for food. Huge numbers of dead birds were washed up on the shores. The 2006 dead zone, which remained for nearly four months, was three times bigger

than any seen in the region before, said Dr Francis Chan, from Oregon State University in Corvallis. "It grew to an area the size of the state of Ohio and lasted much longer than we thought would be possible, from something that we tracked day to day to months on end," he said, "it went from a low oxygen system to a no oxygen system. This had a dramatic effect on marine life." (4)

One of the most disturbing effects of increased carbon dioxide levels in the atmosphere is that when carbon dioxide dissolves in seawater it increases acidity. This effect is now considered as one of the most pressing environmental threats facing Earth. (4)



By J. Lubchenco.JPG Dr Weeks launches the Phantom submersible to survey the extent and degree of the effect of the low oxygen condition on marine life off the Oregon coast source, the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO), Oregon State University).

Thomas E. Lovejoy, president of the H. John Heinz III Center for Science, Economics and the Environment, has just rewritten the paperback edition of *Climate Change and Biodiversity*, his latest book, to highlight the threat of ocean acidification. "It's the single most profound environmental change I've learned about in my entire career," he said last week. (5) Increasing atmospheric carbon dioxide is, according to the USA National Center for Atmospheric Research and the National Oceanic and Atmospheric Administration, 'dramatically altering ocean chemistry and threatening corals and other marine organisms that secrete skeletal structures.' Scientist first thought that the oceans' could mitigate the climate warming effects carbon dioxide through its absorption, thus acting as a sink. However, by absorbing up to 30per cent of carbon dioxide emissions the oceans acidity is increased. (5)

Marine creatures including corals, plankton and tiny marine snails need calcium carbonate from seawater to build their shells and skeletons. Oceans are already more acidic than they have been for millions of years and their acidity is increasing. An illustration of the expected effect of increasing acidity is that corals grow half as fast when exposed to the level of carbon dioxide projected to exist by 2050. Coupled with the higher sea temperatures because of climate change, already contributing to coral bleaching and acidity dissolving their skeletons, corals may not survive by the end of the century.

Although the fate of plankton and marine snails may not seem as compelling as vibrantly colored coral reefs, they are critical to sustaining marine species such as salmon, redfish, mackerel and baleen whales. "These are groups everyone depends on, and if their numbers go down there are going to be reverberations throughout the food chain," said John Guinotte, a marine biologist at the Marine Conservation Biology Institute, "when I see marine snails' shells dissolving while they're alive, that's spooky to me." (6).

All these problems in the marine environment come for excessive carbon dioxide levels in the atmosphere. Holdren said "many of the most difficult and dangerous environmental problems at every level of economic development arise from the harvesting, transport, processing, and conversion of energy." He urged scientists and engineers to get personally involved in developing solutions, and called on scientist to contribute at least 10 per cent of their to "to working to increase the benefits of science and technology for the human condition and to decrease the liabilities."



Leopard seal feed opportunistically on a range of species from tine krill, through penguins to other seals. However, their adaptable diet will only for stall their eventual demise as the Antarctic food web collapses due to climate warming. Image from www.coolantarctica.com.

Encouraging is the growing involvement of corporate leaders in addressing climate change, where leaders called for the swift enactment of strong USA national legislation to reduce greenhouse gas emissions; ref. "Major Businesses and Environmental Leaders Unite to Call for Swift Action on Global Climate Change' Natural Resources Defence Council, <http://www.nrdc.org/media/2007/070122.asp>

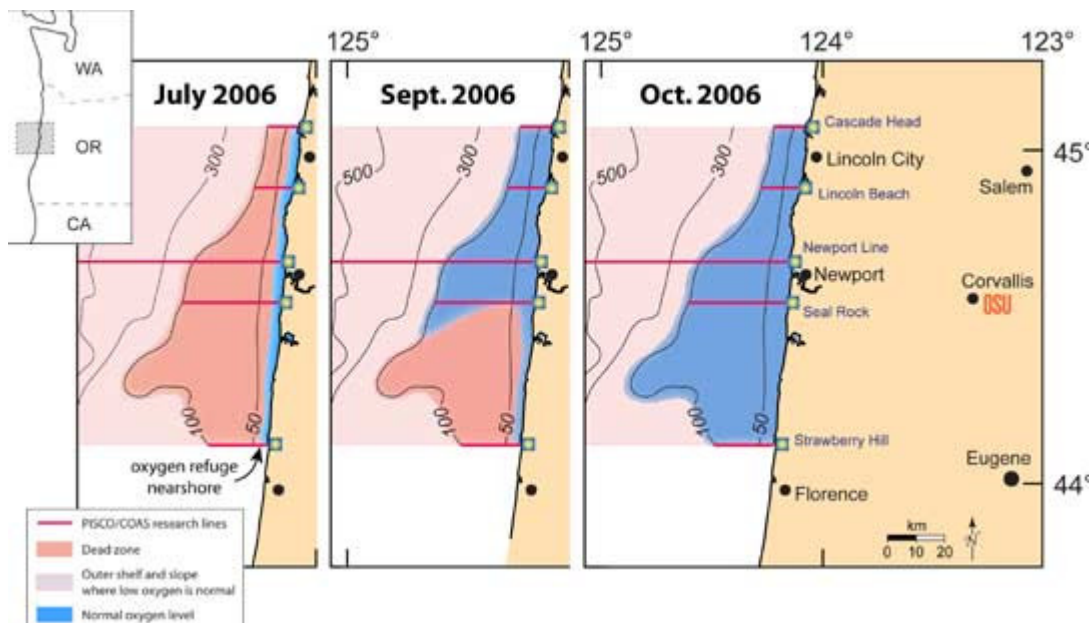
However, there has been a "pathetically small" amount worldwide of public and private investment in energy research and development. When asked about the policies of the Bush administration, Holdren said: "We have seen some tendencies toward fact-averse governance". This statement could equally apply to the Howard administration.

For instance Holdren said the U.S. Department of Energy's investment in energy research and development today is less than half of what it was 30 years ago, and has reduced funding for climate change research in the past four years.

On environmental and climate issues, Holdren stressed that the climate change emergency is having a palpable impact now. 2005 was the hottest year on record, he said. The 13 hottest years on record all have occurred since 1990. Twenty-three out of the 24 hottest years have occurred since 1980. If things continue to be mismanaged by government we face a dismal future and our children a disastrous future.

Holdren said that warming temperatures don't simply make the weather warmer-they destabilize the weather and generate more extremes, Holdren said. Some areas are getting wetter; others are experiencing unusual long-term droughts. Cyclones are becoming more powerful. Between 1950 and 2000, the number of major floods and wildfires has increased dramatically in almost every region of the world.

Holdren said solutions must be pursued across a range of channels-economics, science, medicine, technology, and education. And those strategies must be applied to a range of related problems-providing clean water and medical care, reducing carbon emissions, checking deforestation and improving public understanding of actions that can address the challenges at hand.



The extent and duration of the die-off in 2006, due to low oxygen concentrations in the bottom water. This years (2007) die off was much more extensive and lasted for an even greater period than that of 2006 source, the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO), Oregon State University).

Geo-engineering projects have been flagged as a way to help cool the atmosphere or remove greenhouse gases. However, these would require enormous investment and in practice are often 'pie in the sky'. It is interesting that often the same interests that called sound scientific information and evidence of global warming 'pie in the sky' now suggest their interests such as discredited solutions including nuclear energy as inevitable. Meanwhile valid and proven solutions from competing industries, including those harnessing solar and wind energy, have been systematically discredited and lobbied against.

In any case it is becoming increasingly apparent that the profligate use of energy, and other resources is wrong and the solution to greenhouse gas emissions are to lower energy uses and use non-threatening renewable energy sources. "Belief in technological miracles," Holdren told reporters, "is generally a mistake."

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