

Articles to use for Lesson 1: Critical Evaluation of News Articles
SEE Module – Ocean Acidification: A Systems Approach to a Global Problem

Contents and Instructions: Please see the complete lesson plan for more information. This document gives teachers a quick summary of each of the articles we suggest passing out to your students as part of Lesson 1. The separate file, “Combined 38 Articles.pdf” contains copies of the actual news pieces for student distribution.

This document includes 3 sections. Section 1 includes summaries, written for teachers, of all of the articles to be distributed to students for Lesson 1. Section 2 includes longer articles that you may use, however, are not part of the formal content for this lesson. Section 3 includes additional articles that were found after the initial lesson was constructed that you could use for additional or replacement articles as you see fit.

SECTION 1 – SUMMARIES OF 35 ARTICLES FOR LESSON 1

1. **Acidified seawater showing up along coast ahead of schedule;** By Sandi Doughton, Seattle Times science reporter; May 23, 2008;

http://seattletimes.nwsources.com/html/nationworld/2004433462_acidoceans23m.html

Summary: Seattle researchers are stunned to discover that vast swaths of acidified seawater are showing up along the Pacific Coast and reaching the continental shelf, where most marine cultures live. Climate models predicted it wouldn't happen until the end of the century. Researchers also believed the most acidified water was confined to the deep oceans, but that's not true anymore. What's causing the change, and what are the ramifications for the Pacific Northwest's coastline and its ecosystems?

Key words: greenhouse-gas emissions; oceans' chemical balance; marine life impacted; corals; fish eggs & larvae; global warming; CO₂, carbonic acid; ocean currents/upwelling.

2. **The Bergen Mesocosm – a case study;** published January 7, 2009;

<http://oceanacidification.wordpress.com/2009/01/07/the-bergen-mesocosm-a-case-study/>

Summary: The purpose of the Bergen mesocosm research experiment was to attempt to unravel the consequences of ocean acidification on microbes, which the scientists say are the most important organisms in the sea. What are those microbes? How does CO₂ affect them? What role do the microbes play in the production of ocean phytoplankton? How do the researchers think the existing microbe population will respond to on-going changes in the water pH levels? And, how can the metagenomic DNA sequencing mentioned in this article unravel these mysteries?

Key words: ocean acidification; carbon dioxide (CO₂); acidic; oceans; pH of seas; microbes; phytoplankton; archaea.

3. **Ocean researchers dive deeper into Puget Sound's acidification;** By Craig Welch, Seattle Times environmental reporter; February 27, 2012;

http://Seattletimes.nwsources.com/html/localnews/2017613197_acidification

Summary: This article provides graphic examples of what could happen to Northwest sea life when Puget Sound's pH level drops. What does this do to the mussels, the sea urchin larvae, squid metabolisms, sea stars, barnacles, shells of oyster larvae, and fish catches? Is water acidification the sole cause of these problems or do other factors also come into play? What do the researchers think?

Key words: ocean chemistry; acidic marine water; carbon dioxide emissions; climate change; water temperature; harm to marine life.

4. **The Coming Diatom Economy**; By Jeremy Elton Jacquot of Tree Hugger; October 4, 2007;
<http://www.treehugger.com/clean-technology/the-coming-diatom-economy.html>

Summary: British scientists from the University of Oxford cite the economic, cost-effective and eco-friendly uses that diatoms' silica shells (known as frustules) can be put to for industrial scale production of such things as cosmetics, fabrics, possible water-repellent paint, credit card holograms and other polymers. Why do diatoms have such a low carbon footprint? What conditions would prevent diatoms from being used in the future? Two questions not asked in the article are: What impact could their loss have on world economies? What happens to the oceans and marine life if diatoms disappear? What's their role in the ocean?

Key words: diatoms; algae; open oceans; phytoplankton; ocean acidification.

5. **Ocean Acidification Changes Nitrogen Cycling in World Seas**; By ScienceDaily; December 20, 2010;
<http://www.sciencedaily.com/releases/2010/12/101220163258.htm>

Summary: This article postulates the following three things: that (1) increasing acidity in the sea's waters may cause fundamental changes in how nitrogen is cycled in the oceans; (2) that nitrogen is one of the most important nutrients in the oceans; (3) and we don't know how ocean acidification might affect the ammonia oxidizers, who are critical microbial players in the ocean's nitrogen cycle. "With a decrease in average ocean pH from 8.1 to 8.0 (greater acidity), the scientists estimate that up to 25 percent of the ocean's primary food production could shift from nitrate-to ammonium-supported." What does that mean? And, what are the ramifications for marine life and our oceans, in general, if this is the case? What is the nitrogen used for in the oceans?

Key words: ocean acidification; nitrogen cycling; nitrification; ammonia oxidizers; marine ecosystems; greenhouse gas nitrous oxide; human-derived carbon dioxide.

6. **A Wave of Toxic Green Beaches, Saint-Michel-en-Greve, Brittany, France**; By Sharlene Pilkey, Coastal Care, October 2009;
<http://coastalcare.org/2009/10/saint-michel-en-greve-brittany-france/>

Summary: Rotting algae on Brittany beaches is releasing lethal amounts of hydrogen sulfide gas (H₂S) when people walk on the green seaweed. People and animals have died or fallen ill from the noxious fumes, and entire beach/nearshore ecosystems are wiped out during the algae blooms. In Brittany, the blooms are attributed to excess nitrate rich fertilizers from French pig farms situated near rivers running into the sea, which combined with hot weather and warm water, cause the algae problem. Similar outbreaks are documented in China, Massachusetts, and Oregon. Agribusiness along coasts, fertilizers to boost food production, and global warming are blamed as the culprits. What do you think? What are the politics and economic forces that could stop this? What's the link between nitrates and nitrogen?

Key words: hydrogen sulfide gas; rotting algae; seaweed; hot weather; warm water; toxic beach algae; global warming; excess nitrate rich fertilizers.

1. **Melting Ice Sheets Can Cause Earthquakes, Study Finds**; By Mason Inman for National Geographic News, March 14, 2008;
<http://news.nationalgeographic.com/news/2008/03/080314-warming-quakes.html>

Summary: Global warming may be triggering massive earthquakes and may cause more in the future as ice continues to melt worldwide. This is the conclusion of researchers at Ruhr University Bochum in Germany, who used sophisticated computer models to simulate how ice sheets affect

the Earth's crust. The study showed that earthquakes are "suppressed in presence of the ice and promoted during melting of the ice." As the ice sheets melt, they can release pent-up energy and trigger massive earthquakes. How does this theory apply to the West Coast of the United States and other countries in the Ring of Fire, which are susceptible to earthquakes, but have no glaciers or massive ice sheets? Is this study corroborated by other scientists? Is global warming really responsible?

Key words: melting ice sheets; pent-up energy; global warming.

2. **Global Climate Change and Infectious Diseases;** By Emily K. Shuman, M.D. of New England Journal of Medicine, March 25, 2010;

<http://www.nejm.org/doi/full/10.1056/NEJMp0912931>

Summary: Rising temperatures and changing rainfall patterns will spread vector borne and waterborne infectious diseases into geographic areas where these diseases previously did not exist. This has already happened in the highland regions of East Africa where malaria was spread as a result of much warmer and wetter weather than usual, which attracted mosquitoes to this new geographic area. Because the malaria was introduced into a largely non-immune population, the rates of illness and death that resulted from the disease were much larger than normal. The article infers that global climate change will have dire negative impacts on global health.

Key words: climate change; greenhouse gases; radiation; global warming; infectious diseases.

3. **Global Photosynthesis: New Insight Will Help Predict Future Climate Change;** By ScienceDaily; October 2011;

<http://www.sciencedaily.com/releases/2011/10/111005111811.htm>

Summary: Global photosynthesis is the chemical process governing the way ocean and land plants absorb and release CO₂ into the atmosphere. It is also a tool for predicting future climate change. By analyzing air samples, tracing the path of oxygen atoms in CO₂ molecules, and identifying the EL Nino-Southern Oscillation phenomenon as a regulator of the type of oxygen atoms found in CO₂ from the far north to the south pole, scientists were able to tell how long the CO₂ had been in the atmosphere and how fast it has passed through plants. They then deduced that the global rate of photosynthesis is occurring 25% faster than previously thought, and now believe "their new estimate of the rate of global photosynthesis will help guide other estimates of plant activity, such as the capacity of forests and crops to grow and fix carbon, and help redefine how scientists measure and model the cycling of CO₂ between the atmosphere and plants on land and in the ocean."

Key words: climate change; photosynthesis; CO₂; plants; carbon cycling; ocean algae; carbon emissions.

7. **Whale poop is vital to ocean's carbon cycle;** By Wendy Zukerman, NewScientist; April 22, 2010

<http://www.newscientist.com/article/dn18807-whale-poop-is-vital-to-oceans-carbon-cycle>

Summary: This article addresses the cycle of life in the Antarctic Southern Ocean and the role that Antarctic baleen whales, iron, phytoplankton, and krill play in enabling the Ocean to sequester CO₂ from the atmosphere. Antarctic baleen whales play a vital ecological role in the Southern Ocean because their faeces contain huge quantities of iron. The iron is crucial to ocean health because the plankton need it to grow. When the numbers and size of phytoplankton grow, Antarctic krill feed on the phytoplankton, thereby concentrating the iron in their tissues. The whales then eat the krill, and when the whales poop, they inject more iron into the ocean water which then spurs more phytoplankton growth! The end result is swelling populations of

phytoplankton, which absorb CO₂, and make the Antarctic Southern Ocean more healthy and able to boost its carbon storage capacity. 27 samples of faeces from four species of baleen whales found that, on average, whale faeces had 10 million times as much iron as Antarctic seawater. DNA analysis confirmed that the vast majority of the iron in the whale poop came from the krill the whales ate.

Key words: baleen whale faeces; iron; carbon-sequestering; phytoplankton; Antarctic krill; carbon dioxide; ocean ecology.

8. **Adding Iron to Ocean Won't Stop Global Warming;** By Eric Bland of Discovery News; April 13, 2009;

<http://dsc.discovery.com/news/2009/04/13/ocean-iron-carbon.html>

Summary: This article infers that scientists have tried various approaches to stop global warming, with unsuccessful results. The approaches included attempts to (1) lock CO₂ deep in the ocean, which concluded that the geo-engineering technique was not as effective as scientists had hoped; (2) pump CO₂ deep into the underground to remove the CO₂ from the atmosphere; (3) use carbon nanotubes to turn CO₂ into methane or other compounds; and (4) lock up excess carbon dioxide in the world's oceans by adding iron to the oceans to stimulate phytoplankton growth in the hopes that they would remove the CO₂, then die and sink to the bottom of the ocean. After dumping more than six tons of dissolved iron over a 116 mile patch of the southwest Atlantic, the amount of biomass in the test area doubled, but instead of dying (as the experiment predicted), the plankton were eaten by copepods, then by amphipods, and as the carbon moved up the food chain, some of it was released back into the atmosphere as CO₂.

Key words: global warming; CO₂; ocean fertilization using iron; plankton and phytoplankton; food chain; carbon.

9. **More Carbon Dioxide May Create a Racket in the Seas;** By Henry Fountain of The New York Times; December 29, 2009;

http://www.nytimes.com/2009/12/29/science/earth/29obsound.html?_r=2

Summary: The oceans are getting louder as a result of rising carbon dioxide emissions! Increasing acidity levels in the oceans are impacting the oceans' ability to absorb sound, and sound absorption could fall by 60% by 2100. Scientists are researching the effects this could have on marine mammals' hearing and their ability to communicate in a noisier ocean environment.

Key words: carbon dioxide emissions; ocean acidification; seawater chemistry changes; chemical absorption of sounds; reduced sound absorption; dolphins and marine mammals.

10. **Ocean Acidification Poses Little Threat to Whales' Hearing, Study suggests;** By Science Daily; October 11, 2010;

<http://www.sciencedaily.com/releases/2010/10/101011215015.htm>

Summary: Scientists from the Applied Ocean Physics & Engineering Department at Woods Hole Oceanographic Institution designed mathematical models of sound propagation in the oceans which found that the increase in ocean noise will only be 2 decibels higher by 2100; that the louder noise ships make as a result of ocean acidification is a negligible change compared with noise from natural events such as storms and large waves; and that the negligible increase in ocean noise is not likely to worsen the hearing of whales and other animals that rely on sound to navigate, communicate, and hunt.

Key words: ocean acidification; impact on whales' hearing; elevated levels of atmospheric CO₂; sound propagation and noise levels in the ocean.

11. **Ocean Acidification Leaves Clownfish Deaf to Predators**; By ScienceDaily; May 31,2001;
<http://www.sciencedaily.com/releases/2011/05/110531201221.htm>

Summary: Scientific studies demonstrate that ocean acidification not only affects external sensory systems of fish, but also the sensory systems inside their bodies. Ocean acidification causes fish to lose their sense of smell and their ability to hear. Scientists made these discoveries by rearing baby clownfish in three different CO₂ environments, and observing how they responded.

Key words: ocean acidification; CO₂; fossil fuels; coral reefs and predator noise; fish sensory systems.

12. **Jellyfish are taking over the oceans: Population surge as rising acidity of world's seas kills predators**; By David Derbyshire of Mail Online; December 3, 2010;

<http://www.dailymail.co.uk/sciencetech/article-1335337/Jelly-fish-alert-Population-surge-ri>

Note: To access this article online, it is necessary to type in the title of the article in the search box on the website.

Summary: Scientists predict an explosion in the number of jellyfish due to the increasing acidity of the world's ocean. Unlike shellfish and coral reefs, which suffer in acidic ocean waters, Jellyfish are immune to the effects of acidification. As other species decline due to increasing CO₂ levels in the oceans, jellyfish will thrive and move in to fill the ecological niche vacated by marine life that can't tolerate water with lowered pH levels. Jellyfish populations have swarmed Mediterranean beaches in recent years and are a menace to swimmers.

Key words: acidity; CO₂; shellfish; pH levels; jellyfish; coral reefs.

13. **Land - Rising temperatures and shifting precipitation patterns are changing the geographic areas where mammals, birds, insects, and plants that live on land can survive – and are affecting the timing of lifecycle events, such as bud bursts, leaf drop from trees, pollination, reproduction, and bird migration.** By Union of Concerned Scientists.

<http://www.climatehotmap.org/global-warming-effects/plants-and-animals.html>

Summary: This article leads one to conclude that climate change is destabilizing our world, and that forced migrations and extinctions will occur as a result. There is evidence that plants and animals are migrating to higher altitudes and latitudes. Lowland agricultural pests are on the increase, and pine bark beetles in the Kenai Peninsula of Alaska are completing two or three reproduction cycles per year instead of only one, due to warm seasons lasting longer. Bird migrations might begin earlier to coincide with seasonal changes, but the normal insects and creatures that the birds feed on while migrating might not be available during the early timing of their migrations. Certain tree species are predicted to disappear; and rising concentrations of CO₂ in the atmosphere are causing certain potent allergens and noxious plants (such as poison ivy) to thrive in warm and CO₂- rich conditions.

Key words: rising temperatures; CO₂-rich conditions; plant and animal forced migrations and extinctions; de-synchronization of life-cycle events; unsuitable habitats.

14. **Acidity in ocean killed NW oysters, new study says**; By Craig Welch of Seattle Times; April 11, 2012;

http://seattletimes.nwsourc.com/html/localnews/2017961101_oceanacidification12m.html

Summary: Pacific Northwest scientists now have concrete evidence that carbon dioxide being taken up by the oceans is helping kill marine species, particularly oyster larvae and baby oysters at Washington and Oregon hatcheries. The ocean's chemistry has changed and scientists have conducted experiments to show that oyster die-offs occur after high winds provoke upwelling of water from the deep ocean depths. Because the deep, dark waters are removed from sunlight

and photosynthesis, they contain more carbon dioxide than surface water. That natural condition, combined with ocean acidification from greenhouse gases, has changed the PH levels to the point that some oyster species are unable to form strong shells. For now, the oyster industry has been able to add calcium carbonate to the hatchery's water when needed, and they can control when they take in water, to prevent the upwelled corrosive waters from entering into their hatcheries. But, the oyster industry has grave concerns for the future because ocean chemistry problems are expected to get worse, and ocean upwelling events are predicted to occur more often due to climate change. The economic impact could be dire for the West Coast's \$110 million dollar a year oyster industry.

Key words: changing ocean chemistry; greenhouse gases; global warming; ocean acidification; CO₂; oyster larvae; mechanics of climate change; fossil fuels; wind-driven upwelling events; corrosive waters; calcium carbonate.

15. **Upwelling;** By Dr. Steve Gaines, Director Marine Science Institute and Professor of Ecology, Evolution, and Marine Biology at University of California, Santa Barbara & Dr. Satie Airame, Science Advisor at Channel Islands National Marine Sanctuary. This is an ocean explorer NOAA publication.

<http://oceanexplorer.noaa.gov/explorations/02quest/background/upwelling/upwelling.html>

Summary: Winds play a critical role with regard to the oceans! They can push surface waters near coastlines offshore, and as these surface waters are pushed offshore, water is drawn from below to replace them. The upward movement of this deep, colder water is called upwelling. Its ecological effects are very diverse, and can be both beneficial and detrimental to marine life. The cold, nutrient-rich waters that upwelling brings to the surface encourages seaweed growth and supports blooms of phytoplankton, which results in a spectacular food web diversity. (More species of kelps and marine mammals exist in the Pacific Northwest than anywhere else in the world.) The upwelling movement can also transport larval fish and invertebrates to mainland reefs where they eventually settle and grow. But, for those creatures that need to live in shallow waters offshore, upwelling that moves surface water offshore can potentially move the drifting larvae long distances away from their natural habitat, reducing their chances for survival and robbing coastal ecosystems of offspring required to replenish coastal populations. Interestingly, although coastal upwelling regions account for only one percent of the ocean surface, they contribute roughly 50 percent of the world's fisheries landings.

Key words: upwelling; ocean currents; surface waters; deep ocean waters; cold-nutrient rich waters; phytoplankton; larvae; marine animal movement.

16. **Excess Nitrogen Favors Plants that Respond Poorly to Rising CO₂;** By ScienceDaily, June 30, 2010;

http://www.sciencedaily.com/releases/2010/06/100630132742.htm?utm_source=feedburne

Summary: As carbon dioxide levels rise in the atmosphere, scientists, concerned citizens, and policy makers are hoping that the plant kingdom will absorb some of the extra CO₂ in the atmosphere to help mitigate the impacts of climate change. Realizing that plants build their tissue primarily with the CO₂, and that the more CO₂ they take in, the faster they grow, scientists decided to conduct an experiment adding more nitrogen to sedge in the Chesapeake Bay marsh in an attempt to get the sedge to grow even faster. However, within a year, the added nitrogen completely changed the composition of the ecosystem as well as its ability to store carbon, and the sedge that had flourished in the presence of CO₂ was completely overrun by two grass species that had been relatively rare to the area. The grasses responded vigorously to the excess nitrogen, but not to the CO₂! So, the results were surprising and unanticipated. In the end, "the study underscored

the importance of considering the mix of species when you're trying to predict how terrestrial ecosystems will react to global climate change factors." The experiment also showed that "the species that gain a competitive edge under evolving conditions will determine how ecosystems respond to global change."

Key words: CO₂; nitrogen; CO₂ fertilization effect; sedge; grass species; global climate change factors; evolving conditions.

17. Global Warming's Impact May be Detected in Genes, Suggests Study of How Seagrasses React to Heat Waves; By ScienceDaily, November 16, 2011;

<http://www.sciencedaily.com/releases/2011/11/111116062148.htm>

Summary: This article explores the role of genes in Seagrasses' resiliency against heat waves.

Seagrasses are of crucial importance to shallow coastal regions and the marine life and microbes that these shallow coastal areas support. Because extreme heat waves are on the rise and are a major challenge for the seagrass, scientists want to see how the genes in different species of seagrass react to extreme heat waves. In observing that seagrasses in the Mediterranean seem to resist heat better than seagrasses in Northern Europe, the researchers hypothesized that the adaptability to heat seemed to have a genetic basis. To explore this, they collected seagrass samples from different locations in Northern & Southern Europe and subjected them to controlled heat waves in a special test site in the laboratory. By analyzing the activity of the plants' genes, they saw that all the plants showed activation of genes known to buffer heat stress. But, the Mediterranean seagrass was more resilient than the Northern European species in its ability to go back to its normal gene activity immediately after the heat wave. The Northern seagrass species showed signs of irreversible protein damage from the extreme heat. From those observations, the scientists deduced that the critical process determining whether the seagrass will continue to grow or die occurs during the recovery period after the acute heat wave, and that examining gene expression during the recovery period is the way to predict seagrasses' resiliency. The researchers want to continue their research to find out whether there are genotypes in the northern seagrass populations that have the ability to regulate their gene activity back to normal levels following extreme heat waves. If so, seagrass populations in the North and Baltic Sea would be able to adapt to climate change!

Key words: seagrass; genes; global warming; climate change; extreme heat waves; activation of genes; gene expression; seaweed genotypes.

18. Ocean Acidification is latest manifestation of global warming; By Robin McKie of the guardian / TheObserver; May 28, 2011;

<http://www.guardian.co.uk/environment/2011/may/29/global-warming-threat-to-oceans>

Summary: Scientists are studying the effects of a volcano's output of approximately 10 tonnes per day of invisible carbon dioxide bubbling from underground vents in the shallow seabeds at Vulcano Island, near Sicily. Their study highlights the damaging effects the natural forming carbon dioxide is having on the water's acidity level and on the reefs and marine species that inhabit the area. The researchers believe the carbonic acid that the volcanic vents generate will tell us a great deal about how carbon dioxide is going to affect our oceans and marine life this century. They contend that the billions of tonnes of man-made industrial carbon dioxide emissions we are dumping into the atmosphere each year will do irreparable damage to our oceans, and that what is occurring in the waters surrounding Vulcano Island is a glimpse into what our oceans will eventually look like as a result of our human activities: dark brown blooms of macroalgae, and dead reefs void of marine life.

Key words: volcanic output of carbon dioxide; acidic coastal waters; marine species threatened with extinction; reefs eroding; global warming; carbonic acid; calcium carbonate; reproductive activity disrupted.

19. **Ocean Acidification and Its Impact on Ecosystems;** By ScienceDaily; May 26, 2008;
<http://www.sciencedaily.com/releases/2008/05/080526162652.htm>

Summary: According to this article, the effects of the huge input of CO₂ into the oceans only began to be studied in the late 1990's and researchers still do not fully understand the impact that ocean acidification is having on marine organisms and ecosystems. To search for answers, as of 2008, the European Union decided to support the European Project on Ocean Acidification (EPOCA), whose "goal is to document ocean acidification, investigate its impact on biological processes, predict its consequences over the next 100 years, and advise policy-makers on potential thresholds or tipping points that should not be exceeded." There is concern because "ocean acidification is happening at a rate that has not been experienced probably for the last 20 million years." Over 25 million tons of CO₂ dissolve in seawater every day, causing the formation of carbonic acid, which makes the ocean's pH level fall, and results in acidic and corrosive waters that are detrimental to the ocean's health and marine life.

Key words: ecosystems; human activities; tipping points; greenhouse gases; industrial revolution; perturbation experiments; potential for adaptation; physiological changes in the carbon, nitrogen, sulfur and iron cycles.

20. **Climate Change Affects Ants and Biodiversity;** By Newswise - University of Tennessee;
November 4, 2011;

<http://www.newswise.com/articles/climate-change-affects-ants-and-biodiversity>

Summary: Despite their reputation as pests, ants promote plant survival and plant biodiversity by dispersing seeds when they forage for food. The crux of this article is that ants' ability to continue playing this role is threatened by climate change and warming temperatures. An Associate Professor of Ecology and Evolutionary Biology at the University of Tennessee and his colleagues are testing the effects of climate change on ants by heating up patches of forest and tracking how the ants respond. They observed that, on average, the ants foraged for about ten hours at normal temperatures, but when temperatures were raised just a half a degree, the ants stayed in their nests underground and foraged just an hour. What ramifications will this have on the ants, as well as the Great Smoky Mountains, where it is believed that more than half of the plants in that forest understory rely on ants for seed dispersal, nutrient cycling, and soil turnover?

Key words: climate change; climate action; environment; environment policy; environmental activism; biodiversity; biodiversity conversation programs, biodiversity impacts; biodiversity loss.

21. **Whales, Like Trees, Slow Warming;** By Jessica Marshall of DiscoveryNews; February 26, 2010;
<http://news.discovery.com/earth/whales-carbon-climate-change.html>

Summary: This article contends that whales are like the world's forests, sucking climate-changing carbon dioxide out of the atmosphere over their lifetime and socking it away in their bodies. And, according to new research, repopulating the oceans with whales could be as good for battling climate change as planting trees. When they die, each dying whale carries tons of carbon to the sea floor as its massive body sinks, storing the carbon there for centuries where it can't harm the climate. Is this true? Can it be verified? How would you find out?

Key words: whales store carbon; analogy between repopulating the oceans with whales and planting trees; commercial whaling; photosynthesis; phytoplankton; zooplankton.

22. **IISc to extract oil from Diatoms, algae**; By Biotech News Update; July 4, 2009;

Note: To access the above-referenced article, it is necessary to go to the Internet and type in the title:
IISc to extract oil from Diatoms, algae.

Summary: Scientists from India and Canada are collaborating to make global warming a thing of the past! They believe the answer to clean and sustainable energy production lies in the **microscopic algae – diatoms**. Some biologists believe that a majority of the world's crude oil originated from diatoms. Per Dr. T.V. Ramachandra at the Indian Institute of Science (IISc), diatoms have oil glands that can yield an effective amount of oil. Diatoms also act as carbon sequesters trapping in carbon and releasing oxygen. Because of this, the scientists are hoping that diatoms could work as a replacement for conventional energy or gasoline paving the way for a clean fuel that can effectively work as a solution to tackle global warming.

Key words: oil extracted from diatoms; clean energy; clean fuel; origination of crude oil; diatoms and food chain; carbon sequesters; oxygen; sustainable energy.

23. **Mercury in Seal's Diet Linked to Warming**; By Emily Sohn of Discovery News; May 5, 2009;
<http://dsc.discovery.com/news/2009/05/05/seal-mercury-fish-print.html>

Summary: Researchers suggest there is a link between mercury in seals and the extent of sea-ice in the Arctic. Extreme weather periods in the Arctic seem to cause an increase in the mercury levels in Arctic ringed seals. Cod play a role due to the mercury they contain and the fact that they make up a significant portion of the ringed seal's diet. Between 1973 and 2007, researchers analyzed the mercury levels in the muscle tissues of Arctic ringed seals and found that the mercury levels in seals were highest in years with the most ice-free days and the least ice-free days, but that the mercury levels were lowest in less extreme years. Can these mercury levels be mitigated? Why is it an issue? Where is the cod getting the mercury? And, why do the extreme weather periods cause the seals' mercury levels to change? What are the health ramifications for the Eskimos who eat the seals?

Key words: sea ice vanishing; Arctic; mercury contaminated foods; ringed arctic seals; climate extremes; global warming's effects, cod.

24. **Satellite images of Antarctic emperor penguins will benefit climate change research**; By Mary Ormsby of thestar.com; April 13, 2012;
<http://www.thestar.com/print/article/1161346>

Summary: An orbiting satellite called QuickBird is mapping the Antarctic emperor penguins because they are the proverbial canary in the coal mine as far as ecosystem health and climate change go, per Michelle LaRue of the University of Minnesota's Polar Geospatial Center. In 2009, the satellite images detailed 595,000 penguins in 44 colonies - seven of them never seen before – along the coastline of Antarctica. The monitoring will continue in order to track accurate increases or decreases in their numbers.

Key words: orbiting satellite images; climate change research; Emperor penguin populations; monitor health of penguins and Southern Ocean.

25. **Scientists cite global warming for more heat waves, heavier rainfall**; By Juliet Eilperin & Brian Vastag, April 2, 2012;
http://seattletimes.nwsources.com/html/nationworld/2017895407_climate03.html

Summary: In April, 2012, the United Nations Intergovernmental Panel on Climate Change (IPCC) released a 594-page study which 220 authors from 62 countries collaborated on. Their study suggests that when it comes to weather observations since 1950, there has been a "change in extremes," which stems in part from global warming. They acknowledge that global warming

resulting from human-caused green-house gas emissions does indeed play a role in certain “extreme weather events”, but not all of them. The scientists concluded that it is necessary to make distinctions among differing phenomena regarding the role that climate change plays in each event. For example, there is “limited to medium evidence” that climate change has contributed to changes in flooding. But, there is “low confidence” that long-term hurricane trends over the past 40 years have been driven by the world’s growing carbon output. Extreme heat waves and unusual downpours have been made much more likely and heightened by human-driven climate change according to Dim Coumou of the Potsdam Institute for Climate Impact Research in Germany. And, the IPCC study projects a 90-100 percent chance that sea levels will rise causing extreme coastal high-water levels in the future. However, linking hurricanes, tornadoes and other storms to climate change is much harder because records for these events are poorer than temperature and rainfall records. According to Dim Coumou, “There’s no way to determine whether a single event was triggered by climate change. Rather, we should be asking whether the likelihood of the event was heightened by human-driven climate change.” Pursuant to this article, “Both environmentalists and several major insurers argue policymakers must move quickly to cut carbon emissions and devise strategies to adapt to climate impacts.”

Key words: global warming; heat waves; heavier rainfall; human-caused greenhouse-gas emissions; climate change; carbon emissions; extreme weather; human toll.

26. Killer Whales facing an airborne threat; By Craig Welch of Seattle Times; April 20, 2012;
http://seattletimes.nwsources.com/html/localnews/2018025831_orcas20m.html

Summary: By gathering orca breath samples from the waters of Washington and British Columbia, researchers found that killer whales are inhaling bacteria, fungi and viruses once believed to be found only on land. Some are even antibiotic-resistant. That discovery comes as researchers also learn that respiratory ailments, including pneumonia, may be a leading cause of orca deaths, leading the researchers to conclude that contagions may be of greater concern for orcas than previously thought. Per Davie Bain, an orca expert and affiliate professor at the University of Washington, “We need to improve the barrier between our lives on land and whales’ lives at sea.” Scientists’ ability to understand disease in orcas is going to be crucial for the orcas’ survival, and it is also going to be a big challenge. The raw sewage and other toxic pollutants and pathogens contained in Puget Sound’s sea-surface microlayer are deemed plausible factors in weakening the orcas’ immune systems and making them more vulnerable to disease. Do scientists know when the sea-surface microlayer appeared in Puget Sound? Can anything be done to mitigate it?

Key words: killer whales, inhaling bacteria, fungi and viruses; antibiotic-resistant; whale respiratory ailments; Orca deaths; Puget Sound; disease threats; survival; weakened immune systems; toxic chemicals; sea-surface microlayer; pollution; storm water runoff; sewage.

27. Climate change will impact infectious diseases worldwide, but questions remain as to how; By Katherine Harmon; Scientific American Blog; March 3, 2010;
<http://blogs.scientificamerican.com/observations/2010/03/03/climate-change-will-impact-infectious-diseases-worldwide-but-questions-remain-as-to-how/>

Summary: Scientists attending a symposium held at the New York Academy of Sciences discussed the potential plague of infectious diseases that are threatening to be made worse by projected changes in the Earth’s climate. Even though the scientists argue over details such as whether rising temperatures will increase the number of mosquitoes that can transmit malaria among humans (rather than just shift their range), they urge that it is time to start trying to develop real-world strategies to curtail potential pandemics before they get started. But, without a clear

picture for public health officials, government decision makers and biologists studying the diseases, of how rainfall or daily minimum temperatures are going to change in many areas of the globe, it has been difficult to establish predictions about how infectious diseases, such as malaria or Lyme disease are likely to spread. Despite the challenges, Madeline Thomson, of Columbia University's International Research Institute for Climate and Society, insists that climate change can be a relatively solid rock on which to moor infectious disease planning because "climate is one thing you can actually measure." Did this article give you a clear idea of how climate can be measured?

Key words: infectious diseases; relation between climate change and infectious diseases; potential pandemics; factors influencing spread of infectious diseases; expanded rapid travel; evolution of resistance.

28. New 'ocean acidification' monitoring equipment deployed off LaPush; By Peninsula Daily News staff and news services; last modified July 18, 2010;

<http://www.peninsuladailynews.com/article/20100718/news/307189981/0/SEARCH>

Summary: Acidic water kills free-swimming oyster larvae. This does not bode well for the oysters, the oyster industry, or the Washington coast Indian Tribes that rely on salmon fishing and shellfish farming for their livelihood. Nor does it bode well for the oceans, which are becoming increasingly acidic. In an attempt to monitor and understand the skyrocketing acidity levels in the ocean waters along the North Washington Coast, Puget Sound and Hood Canal, the National Oceanic and Atmospheric Administration (NOAA) and the University of Washington's Applied Physics Laboratory are operating sophisticated monitoring equipment in Washington's waters. The equipment includes a high-tech buoy which checks the composition of seawater coming into Puget Sound and Hood Canal, and a sea-glider, which is a remote-controlled underwater vehicle, that continuously dives and surfaces in order to relay data from the depths. The high-tech buoy will also keep track of the weather, the atmosphere, water chemistry and plankton growth.

Key words: acidity levels in ocean, Puget Sound, and Hood Canal; monitoring equipment; seawater composition; shellfish industry; carbon dioxide absorption; phytoplankton; corrosive water upwelling; oyster larvae; amorphous calcium carbonate shells.

29. Ocean off North Olympic Peninsula 10 times more acidic than thought; By Peninsula Daily News sources; last modified November 30, 2008;

<http://www.peninsuladailynews.com/article/20081130/news/311309992/0/SEARCH>

Summary: This article summarizes the results of an eight-year study on the effects of ocean acidification along the North Olympic Peninsula Coast at Tatoosh Island and the impacts the acidic waters had on the local ecosystem. The researchers discovered, to their surprise, that the water's acidity was rising more than 10 times faster than climate models had predicted, and that in a scenario of increased acidity, not all species dependent on calcium carbonate skeletons and shells, fared badly! The larger mussels and barnacles that usually dominate the ecosystem because they are good at overgrowing and crushing out other species that grow on rocks, suffered, leaving smaller barnacles and calcium-based seaweeds better off. Per the co-author of the study, "...when the mussels decline, it means other species, no matter whether or not they have a shell, can do better." "When you change the playing field—in this case by altering acidity—you can get unexpected responses." "And, the changes we see in the dynamics of the ecosystem may magnify over time." What is the author inferring in that last sentence? What other changes could occur?

Key words: measurements of ocean acidification; acidity-driven shift in coastal ecosystems; carbon dioxide emissions; fossil fuels; carbonic acid; shifts in coastal species; mussels; calcium-based seaweeds; cold-water reefs.

30. **Ocean ‘Time Machine’ Illustrates Global Warming’s Impact on Marine Life;** By Tom Banse, Seattle, Washington VOANews.com

<http://www.voanews.com/english/news/special-reports/american-life/Ocean-Time-Machine-Shows-How-Global-Warming-Impacts-Marine-Life-104770004.html>

Summary: Pacific Northwest Scientists are studying how the oceans suck in excess carbon dioxide from the atmosphere. They are setting up experiments using different water tanks to simulate both pre-industrial conditions, before people started burning fossil fuels, as well as tanks setting up conditions for doubling current CO₂ levels. Scientists have made the frustrating discovery that it’s hard to get high levels of dissolved carbon dioxide out of seawater once it’s in the water. That’s a cause of concern for oysters, whose larvae are unable to form shells due to the increased presence of CO₂ in the oceans, and the resulting acidic water that the CO₂ creates. Coral reefs, which cover only one percent of the seafloor, but support about 25% of all life in the ocean, are also under threat of extinction due to the increased acidity levels. Algae and seaweed, on the other hand, seem to thrive in oxygen depleted waters.

Key words: ocean critters; changes in seawater chemistry; elevated CO₂ levels; fossil fuels; ocean acidification; algae and seaweed; oyster seed survival; coral reefs as breeding grounds for fish.

31. **Changing the Chemistry of Earth’s Oceans;** The New York Times; March 9, 2012;

<http://www.nytimes.com/2012/03/10/opinion/changing-the-chemistry-of-earths-oceans.html>

Summary: Acidification of the oceans, which changes the chemical balance of the oceans’ web of life, has occurred more than once in Earth’s history. Prolonged and intense volcanic eruptions during prehistoric times caused many episodes of acidification that resulted in major extinctions of life. Per paleoceanographers at Columbia University, our oceans are undergoing acidification again, but this time at a much faster rate than during prehistoric times. Per their article published in Science, the oceans may be turning acid far faster than at any time in the past 300 million years. And, while the volcanic activity associated with acidification during prehistoric times occurred over thousands of years and was a result of natural occurring events in nature, this time the acidification of the oceans and its ensuing threat to marine life, is happening as a result of human activity and the burning of fossil fuels, which puts more carbon dioxide in the oceans than the oceans can safely absorb.

Key words: fossil fuels; episodes of ocean acidification; volcanic eruptions; major extinctions; pH of seawater; shells of shellfish; skeletal foundations of corals; coral reefs; calcium carbonate.

32. **Modeling Climate and Acidification Impacts on Fisheries, Aquaculture, and Other Marine Resources; Power Point Presentation** by Paul McElhany, Research Ecologist Northwest Fisheries Science Center.

[http://yosemite.epa.gov/ee/epa/erm.nsf/vwAN/EE-0566-14.pdf/\\$file/EE-0566-14.pdf](http://yosemite.epa.gov/ee/epa/erm.nsf/vwAN/EE-0566-14.pdf/$file/EE-0566-14.pdf)

SECTION 2 – LONGER ARTICLES

1. **Life in the Sea Found Its Fate in a Paroxysm of Extinction;** By Alanna Mitchell; The New York Times; April 30, 2012;

<http://www.nytimes.com/2012/05/01/science/new-studies-of-permian-extinction-shed-light-on-the-great-dying.html?pagewanted=all>

Key words: Permian extinction 252 million years ago; the Great Dying; perturbation of the global carbon cycle; corals at risk; the evolution and rise of gastropods (snails) and bivalves (clams and scallops); calcium carbonate; lack of dissolved oxygen in water; excess carbon dioxide; altered acidity; and higher water temperatures.

2. **Climate change effects on ocean animals;** By New England Aquarium;

http://www.neaq.org/conservation_and_research/climate_change/effects_on_ocean_animals.php

Key words: climate change; ocean animals; polar bears ; decreasing sea ice and ringed seals; rising sea levels impact on sea turtles; right whales; human induced global warming; water currents and water temperature; zooplankton; penguins; impact of warmer waters on lobsters and increasing bacteria; rising temperatures affect on commercial fishing.

3. **Does Rain Come from Life in the Clouds?** By Douglas Fox of Discover magazine; April 20, 2012;

(**Note:** It is necessary to type in the title of the article for it to appear on the Internet)

Key words: The sky's ecosystem affects weather; biological cells in ice crystals in the sky; microbial ecosystem; clouds; dust; nucleation; bacteria and freezing water.

4. **Climate Change and Infectious Disease: Is the Future Here?** By: Catherine M. Cooney, a science writer based in Washington, D.C., has written for Environmental Science & Technology and Chemical Watch; Online: September 1, 2011;

<http://ehp03.niehs.nih.gov/article/info%3Adoi%2F10.1289%2Fehp.119-a394>

Key words: pathogenic yeasts; deadly fungus outbreaks reported in the U.S. Pacific Northwest with possible links to climate change; new species exported from native habitats; human migration; extreme weather; contaminated water; vector shifts; temperature shifts; longer seasons.

5. **Shell –Shocked: How different creatures deal with an acidifying ocean;** By Earth Magazine; March 10, 2010;

<http://www.earthmagazine.org/article/shell-shocked-how-different-creatures-deal-acidifying-ocean>

Key words: carbon dioxide; carbon; climate change; crustaceans; ocean chemistry; oceanography; ocean acidification; carbonate.

6. **Northwest Ocean Acidification – The hidden costs of fossil fuel pollution;** By Jennifer Langston of Sightline Institute; November 2011;

<http://www.sightline.org/research/energy/ocean-acidification/northwest-ocean-acidification/OA-primer.pdf>

Key words: disrupted ocean systems; fossil fuel pollution; carbon dioxide emissions; carbonate ions; corrosive water; upwelling events; marine eco-systems; economic consequences; shellfish hatcheries; greenhouse gas emissions; ocean monitoring.

7. **The Climate Fixers – Is there a technological solution to global warming?**

The New Yorker; By Michael Specter; May 14, 2012

http://www.newyorker.com/reporting/2012/05/14/120514fa_fact_specter

Key words: geoengineering; climate change; environmental global warming; Hugh Hunt; stratospheric particle injection for climate engineering (SPICE); Russell Seitz.

SECTION 3 – ADDITIONAL ENVIRONMENTAL & OCEAN ACIDIFICATION ARTICLES

A good method for finding local articles is to go to Google and search using key words, such as Seattle Times Ocean Environmental or Seattle Times Ocean Acidification, etc.

Also, here are a few more found after the above list was published:

- Local Oyster grower moves oyster harvesting to Hawaii due to Ocean Acidification:
http://seattletimes.nwsourc.com/html/localnews/2018496037_oysters22m.html
- Report: Coastal waters to rise by 6 inches by 2030
<http://www.ktvu.com/news/news/local/report-coastal-waters-rise-6-inches-2030/nPck7/>
- Sea rise predicted to be faster on East Coast than the rest of the globe
http://seattletimes.nwsourc.com/html/business/technology/2018517214_apusscieastcoastrisingseas.html
- July 6, 2012, Once abundant West Coast oysters near extinction
<http://www.sfgate.com/science/article/Once-abundant-West-Coast-oysters-near-extinction-3689709.php>
- March 10, 2010: Two experiment based articles that discuss organisms that are expected to “win” or “lose” as a result of ocean acidification.
http://www.whoi.edu/cms/files/OceanAcid_68964.pdf
<http://www.earthmagazine.org/article/shell-shocked-how-different-creatures-deal-acidifying-ocean>
- October 6, 2012: Scientists Adopt Tiny Island as a Warming Bellwether
<http://www.nytimes.com/2012/10/07/us/scientists-in-washington-state-adopt-tiny-island-as-climate-change-bellwether.html?emc=eta1>
- December 2, 2012: The State of WA tackles Ocean Acidification by signing an executive order to plan and commit to research.
http://www.nytimes.com/2012/12/03/opinion/marine-life-on-a-warming-planet.html?nl=todaysheadlines&emc=edit_th_20121203&r=0