St. Louis Public Schools
Continuous Learning for Students
High School Biology

Welcome to Virtual Learning for Biology STUDENTS!

(Hybrid of Online and Offline Materials)

Students are encouraged to maintain contact with their home school and classroom teacher(s). If you have not already done so, please visit your child's school website to access individual teacher web pages for specific learning/assignment information. If you cannot reach your teacher and have elected to use these resources, please be mindful that some learning activities may require students to reply online, while others may require students to respond using paper and pencil. In the event online access is not available and the teacher cannot be reached, responses should be recorded on paper and completed work should be dropped off at your child's school. Please contact your child's school for the dates and times to drop off your child's work.
If you need additional resources to support virtual learning, please visit: https://www.slps.org/extendedresources

Overview of Weeks 6 and 7 (April 27-May 8): With this instructional plan, students will engage with projects on an ecological issue of their choosing and endangered species awareness. Students will provide solutions to minimize human impact on chosen ecological problem and create a public service announcement to raise awareness about a specific endangered species. This plan accommodates students who do and do not have access to technology/ internet. **Please keep in mind that daily breakdown of tasks is only a suggestion of pacing and resources.**

To access all pdf files in this document go HERE.

For additional information on Continuous Learning go to https://www.slps.org/keeponlearning

For questions related to this instructional plan, please contact:

Valentina Bumbu
Science Curriculum Specialist
valentina.bumbu@slps.org

Jeremy Resmann, Zachary Rhodes
Biology Teacher Leaders
jeremy.resmann@slps.org; zachary.rhodes@slps.org

St. Louis Public Schools
Continuous Learning for Students
High School Biology

WEEK 6	**Lesson Objective** *What will you know and be able to do at the conclusion of this lesson?*	**Instructional Activities** *What needs to be done in order to learn the material?*	**Assessment / Assignment*** *How will you show your teacher that you learned the material? What needs to be turned in?*
Monday **April 27** **Tuesday** **April 28**	Explain the various side effects of global climate change and how it further impacts humans.	1. Complete the Climate Change Reading. 2. Write/type the answers to Climate Change Worksheets. 3. (Optional) Watch videos for additional information. TED Talk https://www.youtube.com/watch?v=H2QxFM9y0tY National Geographic https://www.youtube.com/watch?v=G4H1N_yXBiA Bill Nye https://www.youtube.com/watch?v=EtW2rrLHs08	Complete and turn in Climate Change Worksheets. *NOTE: This initial information will provide students background for the Ecological Issue project.*
Wednesday **April 29** **to** **Friday** **May 1**	Explain a specific ecological problem, of their choosing, and provide potential solutions for this issue.	1. Select the ecological issue of your choice. 2. Use the Project Instructions pdf to complete your research. 3. Read the Project Rubric pdf to understand the expectations of the final presentation. 4. Create your presentation following the Project Instructions.	Complete your presentation/ poster/ essay and turn it in.

For questions related to this instructional plan, please contact:

Valentina Bumbu
Science Curriculum Specialist
valentina.bumbu@slps.org

Jeremy Resmann, Zachary Rhodes
Biology Teacher Leaders
jeremy.resmann@slps.org; zachary.rhodes@slps.org

St. Louis Public Schools
Continuous Learning for Students
High School Biology

WEEK 7	**Lesson Objective** *What will you know and be able to do at the conclusion of this lesson?*	**Instructional Activities** *What needs to be done in order to learn the material?*	**Assessment / Assignment*** *How will you show your teacher that you learned the material?*
Monday **May 4**	Investigate causes of endangerment and efforts being taken to conserve species	1. Read Endangered Species Reading pdf. 2. Watch Mass Extinction Video. https://www.youtube.com/watch?v=RAdNCIIYXvo 3. Complete Mass Extinction POGIL editable pdf. 4. Watch Endangered Species Video. https://ninenet.pbslearningmedia.org/resource/idptv11.sci.life.eco.d4kend/endangered-species/support-materials/ 5. Write/type your response to questions in the Endangered Species Worksheet editable pdf.	Complete and turn in the Mass Extinction POGIL and Endangered Species Worksheet associated with each video. *NOTE: This initial information will give students background for the endangered species project.*
Tuesday **May 5**	Create a presentation, webpage, or pamphlet to raise awareness about an endangered species	1. Pick one species listed in the instructions in the Research Project Sheet editable pdf. 2. Write/type your response to the questions in the Research Project Sheet editable pdf.	Complete and turn in your responses to questions in Research Project Sheet.
Wednesday **May 6** **to** **Friday** **May 8**		1. Pick one of three modes to present your project using the Presentation Instructions pdf. 2. Read the Project Rubric pdf of the project to understand the expectations for the presentation. 3. Create a presentation following the instructions.	Complete and turn in final project presentation.

For questions related to this instructional plan, please contact:

Valentina Bumbu
Science Curriculum Specialist
valentina.bumbu@slps.org

Jeremy Resmann, Zachary Rhodes
Biology Teacher Leaders
jeremy.resmann@slps.org; zachary.rhodes@slps.org

Allergies Getting Worse? Blame Global Warming?

One of the few potentially positive effects of climate change, at least in the short term, is that increased concentrations of carbon dioxide in the atmosphere may enhance the growth of plants. That could be good for agriculture — though warming temperatures and changing rain patterns in a warmer world might wipe out that advantage. But there are no unalloyed gifts from climate change. Recent research suggests that global warming will also exacerbate respiratory allergies, as higher CO_2 concentrations lead to vast increases in ragweed pollen production. "There's no denying there's a change," says Paul Ratner, an immunologist with the American College of Allergies. "It's definitely bad news for people who have allergies."

Asthma and other respiratory ailments are already on the rise in much of the world. The World Health Organization estimates that 300 million people globally have asthma, with 250,000 dying from the disease each year. That rate is up considerably over the past few decades, and scientists say a number of factors could be at work. One clear reason is rising levels of ragweed pollen — which can be connected directly to rising levels of CO_2. Researchers have shown repeatedly that elevated levels of CO_2 stimulate weeds to produce pollen out of proportion with their growth rates — meaning you get more pollen per plant, which means more allergies. Even worse, it seems that the weediest species seem to thrive disproportionately in high CO_2 environments. The wave of urbanization in America and much of the world doesn't help — the urban environment, often hotter and with more CO_2than rural areas, is ragweed heaven. "Urban places, because of the baking effect of that increased concrete, definitely pollinate more," says Ratner. It doesn't help that warming will also increase the production of ground-level ozone, a respiratory irritant that worsens asthma.

Longer growing seasons in a warmer world may further worsen allergies. A study in September's *Journal of Allergy and Clinical Immunology* reported data from 1982 to 2001 showing that, for example, increasingly early pollination of the European olive in Spain led to higher overall pollen counts, similar to what is found in warmer parts of the Mediterranean; comparable outcomes can be expected in other temperate parts of the world as climate change kicks in. A similar effect will also be felt in the northward shift of what is known as the hardiness zones — meaning that northern countries where allergies were once rare may no longer be as safe. "Those borderline northern regions will definitely feel changes," says Ratner.

The causes of allergies and respiratory disorders are complex, and scientists cannot predict exactly how much impact climate change will have on their global rates. But the recent data — records on pollen counts rarely go back more than 20 years — certainly would indicate that warming will only make things worse. So, what can be done to help millions of sneezing, watery-eyed patients? As allergy sufferers already know, not a whole lot. But any action taken to control rising CO_2 levels might at least help stem the increase in global allergy rates. So far, the global asthma epidemic shows no signs of abating, and in a warmer world, effective treatments for allergies will likely become even more important. One option for allergy suffers might be to start agitating for action to reduce CO_2 emissions — after all, the only thing you have to lose is your breath.

Source: Time Magazine, Bryan Walsh, September 15, 2008.
http://www.time.com/time/health/article/0,8599,1841125,00.html

How Climate Change Will Impact Animals

The threats to wildlife on the African island of Madagascar are manifold: rampant deforestation that has stripped most of the island of its original forest cover, leaving a wasteland; a human population that is growing at 3% a year, straining natural resources and hunting animals for food, especially Madagascar's emblematic lemurs; extractive industry, including a nickel mine not far from a national park that could become the world's biggest.

There's another danger that's invisible, but may be more dangerous than the others put together: climate change. Global warming will do to wildlife what it may do to humans. As the climate changes, animals may be forced to move out of the habitats they're accustomed to — like human refugees. "Global warming is something that all conservationists are worried about," says Russell Mittermeier, the president of Conservation International. "It has the possibility to undo a lot of the work we've done."

While the impact of climate change on human populations is likely to be dire, we're pretty good at adapting to change overall. Animals, however, are not. When their habitats change irrevocably — when the rain forest dries up or cool mountains in tropical zones heat up — animals may simply go extinct. A recent study in *Science* demonstrates how that can happen. Robert Colwell, an evolutionary biologist at the University of Connecticut, analyzed data from nearly 2,000 species of plants, insects and fungi in the tropics, where organisms often lack the ability to escape warming temperatures by going north or south; instead, they have to go up in elevation to find cooler temperatures. Colwell found that as populations in lowland areas move up, they tend not to be replaced. That means that we may see a reduction in overall biodiversity and what scientists call "species richness." Meanwhile, species that already live at the highest elevations have no place to go, except perhaps to extinction. Case in point: the Golden Toad, which lived in the high-altitude cloud forests of Costa Rica and suddenly went extinct. Its disappearance may be due in part to warming, which made its habitat unlivable.

The toad may be the first animal whose extinction scientists will link to global warming, but it certainly won't be the last. Last year, the U.N.'s Intergovernmental Panel on Climate Change estimated that if global temperatures increase more than two to three degrees Farenheit above current levels — which seems quite possible, given current trends in carbon emissions — up to one-third of the species on Earth could be at risk for extinction. "We're already seeing nature react badly to climate change," says Larry Schweiger, the president of the National Wildlife Federation. "We're changing the rules of the game."

For one thing, the grand design of conservationism is to create reserves, protected areas like national parks where wildlife can live free from the impact of human populations. That strategy has been overwhelmingly successful, but conservationists now fear that global warming could make those reserves meaningless, if animals that are accustomed to a different climate can't survive in them. "We're used to focusing on protecting real estate," says Schweiger. "Now we have to be able to make sure animals can move to safe areas."

First, conservationists say, we need to do everything we can to slow carbon emissions and reduce the impact of climate change. "That's priority number one," says Mittermeier. But some degree of warming is inevitable, so conservationists have to prepare. That means creating not just reserves, but safe nature corridors that would allow wildlife to migrate in the face of rising temperatures. Another method is to try to connect existing reserves through reforestation — a technique already underway in Madagascar, where the government is looking to vastly increase the total amount of protected land. What's certain is that we need to act. If we don't, says Schweiger, "Climate change could undermine the conservation work of whole generations."

Source: Time Magazine, Bryan Walsh, October 13, 2008.
http://www.time.com/time/health/article/0,8599,1849698,00.html

Can Climate Change Make Us Sicker?

What do we talk about when we talk about global warming? It'll get hotter, that's a safe bet; polar ice caps will be melting, and wildlife that can't adapt to warmer temperatures could be on the way out. But what does it really mean for the health of us, the human race? It's a question that remains surprisingly difficult to answer — research into climate change's impacts on human health have lagged behind other areas of climate science. But what we do know has scientists and doctors increasingly worried — a rising risk of death from heat waves, the spread of tropical diseases like malaria into previously untouched areas, worsened water-borne diseases. "When we think about climate change, we think about ice caps and biodiversity, but we forget about human health," says Dr. Jonathan Patz, a professor of environmental studies and population health sciences at the University of Wisconsin-Madison." There are a huge number of health outcomes that are climate sensitive."

The World Health Organization (WHO) and other global health bodies are working to remind us of that fact. On March 31 the American Public Health Association (APHA) launched its first blueprint for combating the health impacts of climate change, and on April 7, WHO will dedicate its annual World Health Day to the intersection between disease and global warming. The message is that severe climate change could fundamentally weaken global public health, that doctors need to be ready to deal with the consequences — and that there is a moral case to be made for reducing carbon emissions to save future lives. "If you look at climate change over the long term, it will profoundly affect the pillars of public health: water, sanitation, air quality and sufficient food," says Dr. David Heymann, Assistant Director-General for Health Security and Environment at WHO. "The fact is that human health should be at the center of the political debate on climate change, but right now that's not the case."

The first step to making that case is understanding exactly what warmer temperatures will do to us and our diseases — and few scientists know more about the topic than Patz, a member of the UN's Nobel Prize–winning Intergovernmental Panel on Climate Change (IPCC). As temperatures increase, and hotter, drier summers become the norm in regions that were once temperate, powerful heat waves —like the one in Europe in 2003, which killed an estimated 35,000 people — will take a toll. At the same time, climate models suggest that rain could become less frequent overall but more intense when it does fall, leading to a double whammy. Longer and fiercer droughts in some areas will worsen hunger, but severe rainstorms carry an increased risk of water-borne diseases like cholera. "It's not just warming, it's climate *change,*" says Patz. "It's changing the air cycle, creating more extreme flooding, more extreme droughts."

For some diseases, climate change will be boon. Take malaria — right now, the insect-borne disease is mostly confined to hot tropical areas, which is why you don't need to take quinine when you're hiking through Central Park. But if temperatures increase, the mosquitoes that carry the malaria parasite will be able to expand their range, while more intense rainstorms will give them more places to breed. A report this year by Australia's Center for Epidemiology and Public Health estimated that between 20 to 80 million more people will be living in malarial regions by 2080, as the parasite expands its range; another study released on April 3 by British doctors raised the possibility that insect-borne diseases — virtually unknown in the cool U.K. — could hit the British isles thanks to climate change. "There's real worry about malaria," says Heymann. "Malaria becomes a more threatening disease as it spreads to new areas where people lack immunity because they haven't had it before."

WHO and other bodies are pushing to strengthen the global public health system in preparation for the changes that global warming might bring. That means readying societies to deal with heat waves — ensuring that the most vulnerable elderly aren't left on their own — and improving defenses against vector-borne diseases, with anti-malaria nets and medicines like artemisinin. Such preparations will be especially needed in those parts of the developing world — sub-Saharan Africa, south Asia — that will bear the brunt of climate change. But Patz would also like to see public health tackle carbon emissions directly, cutting off global warming at the source. For him, carbon dioxide should be treated as a pollutant that damages human health, albeit indirectly, and it's in our medical interests to reduce it. "Energy policy becomes one and the same as public health policy," says Patz.

Policies that cut carbon emissions can have a direct positive impact on human health now as well. Imagine how much better off our environment *and* our cholesterol levels might be if more of us biked to work rather than drove — or if city planners put greater emphasis on designing more walkable communities and ensuring sustainable public transportation. But the reality is that climate change is happening today, and will be worse tomorrow, even if we manage to pull together a global effort to reduce carbon emissions, which seems less likely and more difficult every day. (A commentary in the April 3 edition of *Nature* argued that the technological changes needed to decarbonize energy could be much harder than we thought; meanwhile, over in Bangkok, diplomats at the U.N. climate conference last week made little progress on hammering out the successor to Kyoto.) If there is money to be spent on preparing the world for the health impacts of climate change, the priority should be adapting our public health system to a warmer world, versus spending on carbon mitigation. Global warming to some degree will be inevitable — but human suffering needn't be, if we're smart enough to prepare.

Source: Time Magazine, Bryan Walsh, April 4, 2008.
http://www.time.com/time/health/article/0,8599,1728139,00.html

Why Global Warming May Be Fueling Australia's Fires

The raging infernos that have left more than 160 people dead in southern Australia burned with such speed that they resembled less a wildfire than a massive aerial bombing. Many victims caught in the blazes had no time to escape; their houses disintegrated around them, and they burned to death. As firefighters battle the flames and police begin to investigate possible cases of arson around some of the fires, there will surely be debates over the wisdom of Australia's standard policy of advising residents to either flee a fire early or stay in their homes and wait it out. John Brumby, the premier of the fire-hit Australian state of Victoria, told a local radio station on Monday that "people will want to review that . . . There is no question that there were people who did everything right, put in place their fire plan, and it [didn't] matter — their house was just incinerated."

Although the wildfires caught so many victims by surprise last weekend, there has been no shortage of distant early-warning signs. The 11th chapter of the second working group of the 2007 Intergovernmental Panel on Climate Change, for example, warned that fires in Australia were "virtually certain to increase in intensity and frequency" because of steadily warming temperatures over the next several decades. Research published in 2007 by the Australian government's own Commonwealth Scientific and Industrial Research Organization reported that by 2020, there could be up to 65% more "extreme" fire-danger days compared with 1990, and that by 2050, under the most severe warming scenarios, there could be a 300% increase in such days. "[The fires] are a sobering reminder of the need for this nation and the whole world to act and put at a priority the need to tackle climate change," Australian Green Party leader Bob Brown told the Sky News.

Destructive wildfires are already common in Australia, and it's not hard to see why climate change would increase their frequency. The driest inhabited continent on the planet, Australia has warmed 0.9°C since 1950, and climate models predict the country could warm further by 2070, up to 5°C over 1990 temperatures, if global greenhouse-gas emissions go unchecked. Beyond a simple rise in average temperatures, climate change will also lead to an increase in Australia's extreme heat waves and droughts. Southwestern Australia is already in the grip of a prolonged drought that has decimated agriculture and led to widespread water rationing; the region is expected to see longer and more extreme dry periods in the future as a result of steady warming. It's important to acknowledge that no single weather event can be definitively caused by climate change — and it's possible that the current inferno in Australia might have been as intense and deadly even without the warming of the past several decades. Police are beginning to suspect that many of the fires may have been deliberately set, and the sheer increase in the number of homes built in fire-danger zones in southern Australia today puts more people in harm's way, raising the potential death toll.

Still, heat waves and drought set the table for wildfires, and temperatures in the worst-hit areas have been over 110°F (43°C) while humidity has bottomed out near zero. Climate change will continue to be a threat multiplier for forest fires.

That's one more reason why the world must work together to reduce global carbon emissions to minimize the impact of climate change. The trouble is, though, CO_2 cuts won't be enough. As a recent paper in the *Proceedings of the National Academy of Science* points out, even if we are successful in cutting carbon emissions rapidly — hardly an easy task — the momentum of climate change will continue for centuries. That means our ability to adapt to the impacts of warming, including more aggressive responses to wildfires like those in Australia, will become all the more critical, lest natural disasters turn into human catastrophes. But it also means that the world we've become accustomed to will change, perhaps irrevocably. The wildfires in southern Australia are already the worst in the nation's history — but they surely won't be the last.

Source: Time Magazine, Bryan Walsh, February 9, 2009.
http://www.time.com/time/health/article/0,8599,1878220,00.html

Why Global Warming Portends a Food Crisis

It can be difficult in the middle of winter — especially if you live in the frigid Northeastern U.S., as I do — to remain convinced that global warming will be such a bad thing. Beyond the fact that people prefer warmth to cold, there's a reason the world's population is clustered in the Tropics and subtropics: warmer climates usually mean longer and richer growing seasons. So it's easy to imagine that on a warmer globe, the damage inflicted by more frequent and severe heat waves would be balanced by the agricultural benefits of warmer temperatures.

A comforting thought, except for one thing: it's not true. A study published in the Jan. 9 issue of *Science* shows that far from compensating for the damages associated with climate change (heavier and more frequent storms, increasing desertification, sea-level rise), hotter temperatures will seriously diminish the world's ability to feed itself. David Battisti, an atmospheric scientist at the University of Washington, and Rosamond Naylor, director of the Program for Food Security and the Environment at Stanford University, analyzed data from 23 climate models and found a more than 90% chance that by the end of the century, average growing-season temperatures would be hotter than the most extreme levels recorded in the past.

That means that barring a swift and sudden reduction in greenhouse-gas emissions, by the end of the century an average July day will almost certainly be hotter than the hottest heat waves we experience now. And the extreme heat will wilt our crops. Battisti and Naylor looked at the effect that major heat waves have had on agriculture in the past — like the ruthless heat in Western Europe during the summer of 2003 — and found that crop yields have suffered deeply. In Italy, maize yields fell 36% in 2003, compared with the previous year, and in France they fell 30%. Similar effects were seen during a major heat wave in 1972, which decimated farms in the former Soviet Union, helping push grain prices to worryingly high levels. If those trends hold in the future, the researchers estimate that half the world's population could face a climate-induced food crisis by 2100. "I'm very concerned," says Naylor. "How are we going to feed a world of 8 or 9 billion with the effects of climate change?"

It's true that as temperatures warm, there is likely to be a temporary beneficial effect on agriculture. Like people, plants generally prefer warmth to cold, and they may flourish with rising levels of CO2. But research from Wolfram Schlenker at Columbia University shows that, as average temperatures continue to warm, those benefits dwindle and eventually reverse, and crop yields begin to decline. "It simply becomes too hot for the growing plants," says Naylor. "The heat damages the crops' ability to produce enough yield."

What's more, in their study, Battisti and Naylor looked only at the effect of higher temperatures — not at the possible effect of changing precipitation patterns. Yet many climatologists believe that global warming will make dry areas dryer and further damage farming, which is especially dire news for sub-Saharan Africa, a region that already struggles with heat waves, droughts and famines even as population continues to grow. "Climate change is going to be a major concern for Africa," says Nteranya Sanginga, director of the Tropical Soil Biology and Fertility Institute of the International Center for Tropical Agriculture in Nairobi. "We could lose whole growing seasons."

With these frightening predictions in mind, we need to try to heat-proof our agriculture. That can be accomplished by using crops that have proved resistant to extreme heat — like sorghum or millet — to breed hybrid-crop varieties that are more capable of withstanding higher temperatures. We'll need to drop any squeamishness about consuming genetically modified crops. Unless we can tap the power of genetics, we'll never feed ourselves in a warmer world. But we'll need to act quickly. It can take years to breed more heat-resistant species, and investment in agricultural research has shriveled in recent years.

We also need to focus on improving the agricultural productivity of those parts of the world that have been left behind by the Green Revolution — like Africa, where average crop yields per acre remain well below those in Asia or the West. One simple way is to increase the amount of fertilizer available to African farmers. Sanginga notes that about 440 lbs. (200 kg) of nitrogen fertilizer is generally needed to grow five tons (5,000 kg) of maize, but the average African farmer can afford only 8 lbs. of fertilizer. We can also work on safeguarding the degraded soils of Africa, where almost 55% of the land is unsuitable for any kind of cultivated agriculture. Help is on the way: the African Soil Information Service is launching a real-time digital map of sub-Saharan Africa's soils, which should allow farmers and policymakers to make better use of the continent's agricultural resources. "Farmers need to know when to invest and when to hold back," says Sanginga, who is involved with the mapping project.

There's a limit, however, to our ability to adapt to climate change. We need to reduce carbon emissions sharply and soon. If we fail, a warmer future won't just be uncomfortable; it will be downright frightening. "We need to wake up and take care of this," says Naylor. "We won't have enough food to feed the world today, let alone tomorrow."

Source: Time Magazine, Bryan Walsh, January 13, 2009.
http://www.time.com/time/health/article/0,8599,1870766,00.html

The Dire Fate of Forests in a Warmer World

It's not easy to kill a full-grown tree — especially one like the piñon pine. The hardy evergreen is adapted to life in the hot, parched American Southwest, so it takes more than a little dry spell to affect it. In fact, it requires a once-in-a-century event like the extended drought of the 1950s, which scientists now believe led to widespread tree mortality in the Four Corners area of Utah, Colorado, New Mexico and Arizona.

So, when another drought hit the area around 2002, researchers were surprised to see up to 10% of the piñon pines die off, even though that dry spell was much milder than the one before. The difference in 2002 was the five decades of global warming that had transpired since the drought in the 1950s. That led terrestrial ecologists at the University of Arizona (UA) to pose the question, with temperatures set to rise sharply over the coming century if climate change goes unchecked, what impact will it have on the piñon pine?

Unsurprisingly, the outcome doesn't look good. In a new study published April 13 in the *Proceedings of the National Academy of Sciences* (PNAS), scientists at UA found that water-deprived piñon pines raised in temperatures about 7° Fahrenheit (4° Celsius) above current averages died 28% faster than pines raised in today's climate. It's the first study to isolate the specific impact of temperature on tree mortality during drought — and it indicates that in a warmer world trees are likely to be significantly more vulnerable to the threat of drought than they are today. "This raises some fundamental questions about how climate change is going to affect forests," says David Breshears, a professor at UA's School of Natural Resources and a co-author of the PNAS paper. "The potential for lots of forest die-off is really there."

The PNAS study, led by Henry Adams, a doctoral student at UA's ecology and evolutionary biology department, also confirms that hotter temperatures actually suffocate trees in dry times. Piñon pines respond to drought by closing the pores in their needle-like leaves to stop water loss. That keeps them from going thirsty, but it also prevents them from breathing in the carbon dioxide they need to live — and eventually, the drought-stressed trees simply suffocate.

The higher levels of atmospheric CO_2 that would likely be seen in a warmer future won't make much of a difference either — if the pine needles' pores are closed to prevent water loss, CO_2 simply won't get in. Even more worrisome, the PNAS study doesn't take into account possible changes in precipitation patterns in a warmer future, which many climate models say could be drier, exacerbating the impacts of higher temperatures. "We can envision the landscape getting hammered over and over again," says Breshears.

The study took advantage of the university's unique Biosphere 2 research facility. The 7.2 million-cubic-foot dome — famous for an experiment in the early 1990s when eight people lived inside it for two years — allows scientists to recreate almost any climate on Earth. Adams and his collaborators kept two groups of piñon trees inside Biosphere 2 in nearly identical conditions. One key difference: for the experimental group, researchers ramped up the temperature 7° Fahrenheit (4° Celsius), the rough midpoint of the Intergovernmental Panel on Climate Change's business-as-usual predictions for warming in this century. "We thought temperature might play a big role, but that was speculation until we could conduct an experiment," says Adams. "The great thing about Biosphere 2 is that it allowed us to test this out."

Adams' paper is the latest in a number of recent studies that paint a grim fate for the world's forests if warming isn't slowed. A major *Science* study published in January found widespread increase in tree mortality rates in the western U.S., thanks in part to regional warming trends and growing water scarcity. Another study published last month, also in *Science,* found that even the seemingly limitless Amazon rainforest could be highly vulnerable to drought. And since living trees suck up CO_2 from the atmosphere, massive tree mortality due to warming could produce a feedback effect, further intensifying climate change. In the end, we might need a bigger Biosphere 2, because we're on track to screw up Biosphere 1 — otherwise known as the Earth.

Source: Time Magazine, Bryan Walsh, April 14, 2009.
http://www.time.com/time/health/article/0,8599,1891121,00.html

Is Global Warming Worsening Hurricanes?

It could be a sign of just how traumatic 2005's Hurricane Katrina was that when Hurricane Gustav *failed* last week to fully pulverize New Orleans, it was news. The fallout from Gustav was relatively limited, but it was still a major storm, with maximum sustained winds of 110 m.p.h. when it made landfall in Louisiana — strong enough to cause an estimated $20 billion in damages. And Gustav won't be the last this season. Hurricane Hanna gathered strength in the Atlantic last week, and Ike is swirling not far behind, headed now for the U.S. That's just in the Atlantic, this month. Last May in the Pacific, the massive Cyclone Nargis killed an estimated 100,000 people in the Southeast Asian nation of Burma.

All these hurricanes in such a short period of time begs the question: are storms getting stronger, and if so, what's causing it? According to a new paper in *Nature,* the answer is yes — and global warming seems to be the culprit. Researchers led by James Elsner, a meteorologist at Florida State University, analyzed satellite-derived data of tropical storms since 1981 and found that the maximum wind speeds of the strongest storms have increased significantly in the years since, with the most notable increases found in the North Atlantic and the northern Indian oceans. They believe that rising ocean temperatures — due to global warming — are one of the main causes behind that change. "There is a robust signal behind the shift to more intense hurricanes," says Judith Curry, chair of the school of earth and atmospheric sciences at the Georgia Institute of Technology.

Storms tend to run on multi-decadal cycles, so it's difficult to tell from year to year whether the number of hurricanes is really on the rise. So far that doesn't seem to be the case, with the overall number of storms worldwide holding about steady — in fact, some scientists argue that warming might actually bring about a reduction in the overall frequency of storms. But the *Nature* paper argues that warmer sea-surface temperatures will result in stronger storms, because hotter oceans mean the developing storms can draw more warm air, which powers the storm. "Hurricanes are driven by the transfer of energy from the ocean to the atmosphere," says Kerry Emanuel, a meteorologist at the Massachusetts Institute of Technology. "As water warms, the ability of water to evaporate goes up, and a greater evaporation rate will produce a more intense hurricane."

So far, tropical ocean temperatures have risen by about 0.5 degree C since 1970, which could explain the more powerful storms. The *Nature* researchers estimate that every 1 degree C increase in sea-surface temperature would result in a 31% increase in the global frequency of category 4 and 5 storms. Given that computer models indicate that ocean temperatures could rise by up to 2 degrees C by 2100, those are scary calculations. It's especially worrying because the most intense storms do the most damage by far — several minor storms can equal the damage of a single severe hurricane. "The category 1 or 2 storms don't do that much," says Emanuel. "It's the 3 and 4 storms that really do the damage, and we could see more of them."

Not everyone agrees. Records of past hurricane strength are less than perfect, so it's difficult for scientists to be sure that the recent increase in storm intensity hasn't occurred before, in the years before the Earth started warming. And the weather — as we all know — is complicated, which means that it's difficult to model precisely how future warming might affect the formation of storms. Climate models work well on a global level, but they can rarely be applied accurately to areas smaller than 200 square miles — which happens to be larger than many storms. "It's not just a simple relationship with sea-surface temperatures," says Curry. "It's more complicated than that. We need the models to get a lot better."

Models will improve, and over time, we should have a better idea of just how much warming might intensify storms, and how that process works. But that's a secondary issue. Whether or not warming will create more super storms, we know that hurricanes will happen, and we know that they will strike human populations. The difference, as my colleague Amanda Ripley recently pointed out is whether or not we're prepared for them. As population numbers and property development grow in vulnerable areas like the Gulf Coast, natural disasters will get worse even without the effect of warming. Think of the damage that hurricanes have caused even without the possible effect of warming: Hurricane Camille in 1969, which caused over $9 billion in damages, and Hurricane Andrew in 1992, which caused $38 billion in damages. Now imagine those storms potentially amplified by the unpredictable effect of global warming. We need to be prepared. Gustav caused far less damage than Katrina because it was a weaker storm, yes, but also because we were ready this time. But we also need to reduce carbon emissions and blunt climate change — or we may experience storms for which there is no preparation.

Source: Time Magazine, Bryan Walsh, September 8, 2008.
http://www.time.com/time/health/article/0,8599,1839281,00.html

Could Rising Seas Swallow California's Coast?

Imagine San Francisco Airport under water, or Long Beach Harbor in Los Angeles, the second busiest port in America, washed away. Picture Orange County's Newport Beach completely submerged under the encroaching ocean.

That's the soggy future that could be in place for California at the end of this century if climate change continues unabated. According to the Pacific Institute, an environmental NGO that specializes in water, unchecked global warming may cause the world's seas to rise more than 4.6 ft. (1.4 m). The California government commissioned the institute's study, released on March 11, one of a number of forthcoming reports on how climate change will affect the coastal state and one of the most detailed analyses yet on the local impact of rising seas.

The Pacific Institute found that by 2100, an estimated 480,000 Californians will be at risk of increased flooding — almost double the number currently living in disaster-prone areas of the state — along with roads, schools, hospitals and other low-lying coastal infrastructure. Nearly $100 billion worth of coastal property could be at risk — and the cost to protect that land from flooding will likely be in the billions, even if we do control greenhouse-gas emissions. "This change is inevitable, and it's going to alter the character of California's coast," says Heather Cooley, a senior research associate at the Pacific Institute and a co-author of the study.

The report's warnings are so striking in part because it assumes a much higher sea-level rise than previous studies. The 1.4 m figure used in the Pacific Institute report — which comes from research by the Scripps Institute of Oceanography — is considerably higher than the estimates put forth in the U.N. Intergovernmental Panel on Climate Change's (IPCC) most recent assessment in 2007, which projected a sea-level rise of 18 to 59 cm by 2100. But the IPCC numbers were based on older data and took into account only the thermal expansion of the seas. (Water expands as it heats, so warmer seas rise.) The IPCC did not factor in the potentially far greater impact of melting ice caps in Greenland and Antarctica — Greenland alone has enough ice to raise sea levels by more than 20 ft. At the time of the IPCC report, the polar ice sheets were clearly melting, but it wasn't clear how fast they were going or how they would respond to rising temperatures in the future.

New research is clarifying the ice-cap question and the results are sobering. Scientists at the Climate Change Congress in Copenhagen this week presented a study estimating that sea levels could rise globally by 1 m or more by the end of the century, with large regional differences around the world. At the lower end of the estimate, scientists say it's unlikely that seas will rise less than 50cm even if we can get a grip on carbon emissions.

The revised predictions are due to better data on melting in Greenland and Antarctica and from glaciers around the world, which are pouring water into the oceans and causing them to rise. Up to 600 million people in coastal areas around the world could be at increased risk for flooding. "Unless we take urgent and significant mitigation actions, the climate could cross a threshold during the 21st century committing the world to a sea-level rise of meters," says John Church, an oceanographer at the Centre for Australian Weather and Climate Research and one of the study's co-authors.

The Pacific Institute report takes that abstract number and shows what it will mean for the cities, streets, bridges, beaches and power plants in America's most populous — and vulnerable — state. Nearly half a million people will be at risk for what's called a 100-year flood event. That doesn't mean a flood that happens once a century, but rather a disaster that has a 1% chance of happening every year — which means it has a 26% chance of happening over the life of an average 30-year mortgage. The vulnerability is concentrated along the coastline of the Bay Area, where large parts of both San Francisco and Oakland could be threatened with extreme flooding by the end of the century. Even parts of the Pacific coastline that may be shielded from flooding could be at risk for increased erosion. Worse, as with Hurricane Katrina, it will be the poor and those without insurance who will likely bear the brunt of the flooding damage. "There's this notion that those living on the coast are all rich with insurance," says Cooley. "But in fact these populations are often poor, and they will be particularly vulnerable."

The best way to protect California's coast would be to sharply reduce carbon emissions now and hope to avert the worst of the warming. But even if we do cut carbon soon, we've locked in sea-level rise, and we need to begin protecting sensitive coastlines better than we did in New Orleans. The Pacific Institute study suggests that some 1,100 miles of improved coastal defenses — including dunes and seawalls — would be needed to protect against a 1.4 m sea rise. It won't be cheap — the cost will be at least $14 billion up front, according to the Pacific Institute, with an additional $1.4 billion a year in maintenance costs. But even that might not be enough. "Eventually you could see phased abandonment of certain areas that would experience flooding a lot," says Cooley. We're used to controlling the effects of nature, but if we fail to control climate change, we may have to surrender.

Source: Time Magazine, Bryan Walsh, March 11, 2009.
http://www.time.com/time/health/article/0,8599,1884618,00.html

A Last Warning on Global Warming

The language of science, like that of the United Nations, is by nature cautious and measured. That makes the dire tone of the just-released final report from the fourth assessment of the U.N.'s Intergovernmental Panel on Climate Change (IPCC), a network of thousands of international scientists, all the more striking. Global warming is "unequivocal". Climate change will bring "abrupt and irreversible changes". The report, a synthesis for politicians culled from three other IPCC panels convened throughout the year, read like what it is: a final warning to humanity. "Today the world's scientists have spoken clearly, and with one voice," said U.N. Secretary-General Ban Ki Moon, who attended the publication of the report in Valencia, Spain. Climate change "is the defining challenge of our age".

The work of the IPCC, which was co-awarded the Nobel Peace Prize last month with Al Gore, underscores just how momentous that challenge will be. The report predicted that at a warming trend of 3.6 degrees Farenheit — now considered almost unavoidable, due to the greenhouse gases already emitted into the atmosphere — could put up to 30% of species on the planet at risk for extinction. A warming trend of 3° would puts millions of human beings at risk from flooding, wetlands would be lost and there would be a massive die-off of sea corals. Sea levels would rise by 28 to 43 cm, and most frightening of all, the report acknowledged the possibility that the melting of the Greenland ice sheet, which would release enough fresh water to swamp coastal cities, could occur over centuries, rather than millennia. "If you add to this the melting of some of the ice bodies on Earth, this gives a picture of the kinds of issues we are likely to face," said Rajendra Pachauri, the IPCC's chairman.

As if the potential consequences of climate change weren't scary enough, the IPCC emphasized just how little time we have left to try to change the future. The panel reported that the world would have to reverse the rapid growth of greenhouse gases by 2015 to avert the worst consequences. The clock was running. "What we will do in the next two, three years will determine our future," said Pachauri. "This is the defining challenge."

That puts the pressure on the world's leaders to finally do something about global warming. They'll have their last, best chance next month, when energy ministers from around the world travel to Bali, Indonesia, for the annual meeting of the U.N.'s Framework on Climate Convention. There policymakers will begin attempting to negotiate a successor to the Kyoto Protocol, which expires in 2012. "The breakthrough needed in Bali is for a comprehensive climate deal that all nations can embrace," said Ban.

All the nations in the world will play a role in those negotiations, but their success and failure will come down to two countries: the U.S. and China. If the world's two biggest carbon emitters can agree to cap their greenhouse gas emissions — neither signed on for limits under Kyoto — we may stand a chance of averting the grimmest consequences of climate change. If they fail, then the IPCC has already written our future. We'll find out in Bali.

Source: Time Magazine, Bryan Walsh, November 17, 2007.
http://www.time.com/time/health/article/0,8599,1685199,00.html

Is Global Warming Drowning Africa?

Africa has always been predicted to be the continent that will be worst hit by global warming and climate change. Could those predictions be coming true? Extreme rains and floods have made for a very wet summer in Africa and there is no end in sight to the downpours that are swallowing towns and forcing over a million to flee their homes in at least 20 countries. Since June, Uganda, Sudan, Ethiopia and Kenya have had hundreds of thousands of people uprooted from their homes. Scores have died since. West Africa has seen its worst floods in years, with 300,000 fleeing the earth-colored waters of northern Ghana. Meanwhile, forecasts by African meteorologists say the rains have yet to peak. October may be the worst month to come in this very wet year.

This weather is what climatologists predicted, and it is happening even faster than expected," says Grace Akumu, executive director of the Kenya-based Climate Change Network. "We are overwhelmed." The immediate consequences of climate change in Africa? Countries will experience either torrential floods or severe drought during a season. Akumu says that the unpredictable climate will threaten the food supply in Africa and potentially eliminate key crops. Africans are expected to face a severe lack of food and drinkable water by the end of the century.

Scientists on the U.N.'s Intergovernmental Panel on Climate Change warned this week that the effects of global warming are already being felt in Africa. The IPCC's most recent report on Africa predicted a minimum 2.5 degree centigrade increase in the continent's temperature by 2030. Growing seasons will be cut short and stretches of land made unsuitable for agriculture, with yields declining by as much as 50% in some countries. In sub-Saharan Africa, between 25% and 40% of animals in national parks may become endangered. Africa's major bodies of water, including the Nile, will suffer excessive flooding caused by rising sea levels.

Africa is particularly vulnerable because it has a low institutional capacity to combat the changing weather. As a result, says Ugandan climate change specialist James Magezi-Akiiki, "in Africa, adaptation to climate change is more important than mitigation." In response to the floods devouring Uganda, Magezi-Akiiki says that the government will now consider the effects of global warming, such as increased rainfall, in its planning of future infrastructure projects. Ironically, Africa produces far less carbon than other continents, leading some scientists to blame industrialized countries for Africa's climate plight. Uganda's President Yoweri Museveni announced at an African Union summit this year that developed countries were "committing aggression" against Africa by causing global warming.

"There's not much Africa can do — unless other countries cut their greenhouse emissions, our efforts will be undercut," Akumu says. In the meantime, floods, droughts, earthquakes, landslides and other natural disasters are expected to become more frequent, along with the occurrence of diseases such as typhoid, cholera and malaria. Akumu warns that without aid from richer countries in the form of cash to pay for more durable roads and hospitals, Africa will be unable to handle more disasters like this summer's.

Source: Time Magazine, Bryan Walsh, http://www.time.com/time/world/article/0,8599,1664429,00.html

Name:

Allergies and Climate Change

1. How many people currently have asthma?

2. How many people die from asthma each year?

3. What is one reason for the recent increase of people with asthma?

4. What are two causes mentioned in the article for the rise in ragweed pollen?

5. What is a second reason that asthma will be worse if average temperatures continue to increase?

6. What will warmer temperatures do to growing seasons? How will this affect allergies?

7. What solution is offered to combat this issue? How will this help?

Climate Change and Animals

1. What will climate change force animals to do? How will climate change impact animals?

2. What are two examples of habitats changing beyond repair?

3. What are the two possibilities for animals if their habitat changes?

4. What is the concern about animals moving habitats?

5. What happens to the animals at the highest elevations ?

6. What do scientists predict will happen if temperatures continue to rise?

7. What challenges does climate change offer conservationists?

8. What solutions are offered to combat this issue? How will each of these help?

Climate Change and Disease

1. What are the three areas of concern that doctors and scientists have about human health as a result of climate change?

2. What are the pillars of public health?

3. How will each of the pillars be affected by climate change?

4. How does climate change cause heat waves? What will be the effect of these heat waves?

5. How will rainfall affect human health?

6. Explain how climate change will affect malaria.

7. What solutions are offered to this issue? How will each of these help?

Climate Change and Fires

1. Why will fires increase in frequency and intensity?

2. What does the future hold for the number of fire "extreme danger" days?

3. Explain how rising temperatures lead to more fires worldwide.

4. What solutions are offered to combat this issue? How will these help?

5. How can this information be applied to Southern California?

Climate Change and Food Supply

1. What does warmer weather normally mean?

2. How is global warming different from warmer weather?

3. What effect have major heat waves had on agriculture in the past? Give an example.

4. What will happen to food prices? Why?

5. What is the outlook for agriculture in Africa if temperatures continue to rise?

6. What solutions are offered in the article? How will each of these help?

Global Warming and Forests

1. What was the difference between the droughts in the 1950s and the drought in 2002 that the piñon trees were exposed to?

2. How did this affect the piñon tree population?

3. What effect does an increase in temperature have on tree mortality when exposed to drought-like conditions?

4. What is the implication for forests that can be derived from the study on piñon trees?

5. How do piñon trees respond to drought?

6. How does this response relate to carbon dioxide levels?

7. Name two solutions that can be implied from this article. How will each of these help?

Climate Change and Hurricanes

1. Are storms getting stronger? If so, what is causing this?

2. Where are the increases in storm strength being seen?

3. What powers storms?

4. How does global warming affect the strength of these storms?

5. What solutions are suggested to combat this issue? How will each of these help?

Climate Change and Sea Levels

1. How much could unchecked global warming cause the seas to rise?

2. How much will it cost to protect coastal lands from flooding?

3. What two factors lead to the rising sea levels?

4. How many people worldwide will be at risk for coastal flooding by the year 2100?

5. What impacts will occur in California if climate change continues?

6. What solutions are suggested by the article? How will each of these help?

Ecology Issues Project

Objective: You will create a presentation about an environmental issue. You will have to include a description of the issue and provide potential solutions.

Planning: Choose your topic. The list below will give you some ideas, but you may choose something not on the list. If you choose something not on the list, have your topic approved by your teacher before proceeding. Some of the topics may need to be narrowed in focus.

- Saving the Rainforests (or wetlands or any other biome in danger)
- Wildlife Conservation (national parks, reserves, hunting)
- Pollution (air, water)
- Global Climate Change
- Energy Conservation (alternate fuels, hybrid cars, the "green movement")
- Waste Management (recycling, landfills, toxic waste, etc)
- Human Overpopulation (food & water shortages, habitat destruction)
- Genetically modified crops and animals

For Students **without** computer/internet access, choose one of the three below:

- Global Climate Change
- Alternate Fuels
- Deforestation

Research: Browse sites related to your topic, jot down information you think will be important to include in your final product.

For Students **without** computer/internet access, use the following articles (available in the print packet):

- Global Climate Change- https://nca2014.globalchange.gov/highlights/overview/overview
- Alternate Fuels- https://www.nationalgeographic.com/environment/global-warming/biofuel/
- Deforestation-https://www.nationalgeographic.com/environment/global-warming/deforestation/

As you browse sites related to your topic, think about the following questions that you will need to include in your final project presentation:

1. What is the problem? How do we know there is a problem (what evidence is there)?
2. What causes the problem?
3. What are the possible future effects of the problem? How will it effect the world?
4. What is being done to solve the problem? Are there laws related to the topic?
5. What can an individual do to help?

Presentation: Use PowerPoint or similar application, check with your instructor for other options. The following sequence can serve as a guideline, though you are free to organize it in other ways. Try not to clutter a slide with too much information.

Slide 1: Title, Name

Slide 2: Attention grabber, put a thought provoking question or image here

Slides 3-5: Explain the topic, what is the problem and why is it a problem (do NOT copy and paste information from other websites, use your own words.) Include images to help explain your points and to make your slides more interesting

Slides 6-8: Explain what can be done (or what is being done) to solve the problem. You may want to include specific laws and regulations related to your topic here.

Slides 9-10: What can one individual do to help? Offer advice and tips to the class about how individuals can help to solve the problem or promote awareness.

Final Slide: Summarize or restate the problem/issue; include any image credits or sources

For Students **without** computer/internet access, create one of the following:

- Poster that describes the ecological issue and answers the questions above
- Short written paper that describes the ecological issue and answers the questions above

Ecology Issues Rubric	Beginning (1 pts)	Developing (2 pts)	Proficient (3 pts)	Advanced (4 pts)
Creativity	Attempts to open the presentation; however, there is no spark or interest created	Attempts to grab attention, students are not engaged to start with	Somewhat interesting and creative. Lacks interaction of class, or class seems disinterested.	Presentation interesting, class attention maintained and interaction is good. Use of creative visuals.
Content 1 (background info, research)	Does not have a good grasp of the topic, facts misrepresented, or wrong	Topic is not fully covered, some obvious gaps in knowledge of subject or some major errors	Topic is covered with a fair amount of accuracy and information. Some gaps in knowledge evident	Topic is covered thoroughly, presentation shows a firm understanding of the topic and the issues involved.
Content 2 (solutions)	Solutions offered do not relate to topic	Solutions offered, lacking in relationship AND feasibility	Solutions offered are feasible, though lack relationship to problem or vice versa	Solutions offered solve the problem and are feasible
Organization & Syntax	Presentation is disorganized and difficult to follow	Presentation does not follow an organized pattern, meanders or becomes "off-topic", but can still be followed by audience	Presentation mostly follows a logical sequence, some areas not sequential or off-topic, some grammar or spelling errors	Presentation follows a logical and orderly sequence and remains on topic. Easy to follow and understand. No major errors in grammar, punctuation or spelling.
Images	Not related to the topic of presentation	Images used, though they are sloppy, unclear, and/or disorganized	Images relate to the topic, but are unclear and/or disorganized	Images effectively explain the topic and issues, are clear and organized

Extinct and Endangered Animals – Initial Reading

There are no more dinosaurs living on the Earth. They are **extinct**, which means there is no longer a certain kind of plant or animal living anywhere in the world. A **species** is a certain group of living organisms, like dinosaurs, humans, birds, and many others. Scientists believe many organisms, along with the dinosaurs, died out when a large asteroid collided with the Earth. The collision caused a **mass extinction**, which occurs at a faster rate over a very short time-period.

There are usually two reasons for the extinction of animals and other living things. The first is **naturally**, which may take place when animals do not adapt to natural changes in their environment. For example, if the habitat of a bird suddenly changes, and if the bird does not adapt, it could become extinct.

Examples of naturally occurring extinction may take place during a change in the climate. This took place during the Ice Age when the temperature of the Earth was much lower. During a natural extinction, the species may be eliminated by new predators that move into their environment. The food needed to survive may no longer be available.

Another example of this type of extinction was the wooly mammoth, a relative of the elephant, which died out 10,000 years ago due to climate change and the disappearance of its habitat.

The second reason for the extinction of animals is **human interaction**, which includes hunting and habitat destruction caused by people. An animal's environment may be destroyed by pollution or construction, such as the destruction of parts of a rainforest. Humans also overhunt sometimes wiping out an entire species. In addition, the moving of non-native species into an area where they are not usually found may lead to the extinction of another species.

Examples include the Dodo bird that became extinct due to overhunting and other animals moving into its environment. The passenger pigeon died out due to the destruction of its habitat, as well as overhunting. There are many animals that have become extinct, but when animals are in danger of becoming extinct, yet still survive, they are called **endangered animals**.

Endangered means a plant or animal is at risk of becoming extinct. This occurs when the population of a certain animal is so low, that they are in danger of dying out forever and becoming extinct. The reasons for an animal to become endangered are mostly the same as for those that have become extinct. There are many animals in the world today that are on the endangered species list. Some are so in danger of becoming extinct, they can only be found in a zoo.

Some of the endangered animals in the world as of 2017 include the black rhino, found in Africa, where hunting has led to the decline of its population with fewer than 5,000 of them still surviving. The orangutan found in the country of Malaysia is a highly intelligent relative of the ape family, but it too has been endangered due to the loss of their habitat and overhunting. The blue whale is endangered and threatened by climate change, habitat loss, and poisonous substances in the water. Finally, two other endangered species examples include the Bengal tiger, giant panda, mountain gorilla, sea lions, and others.

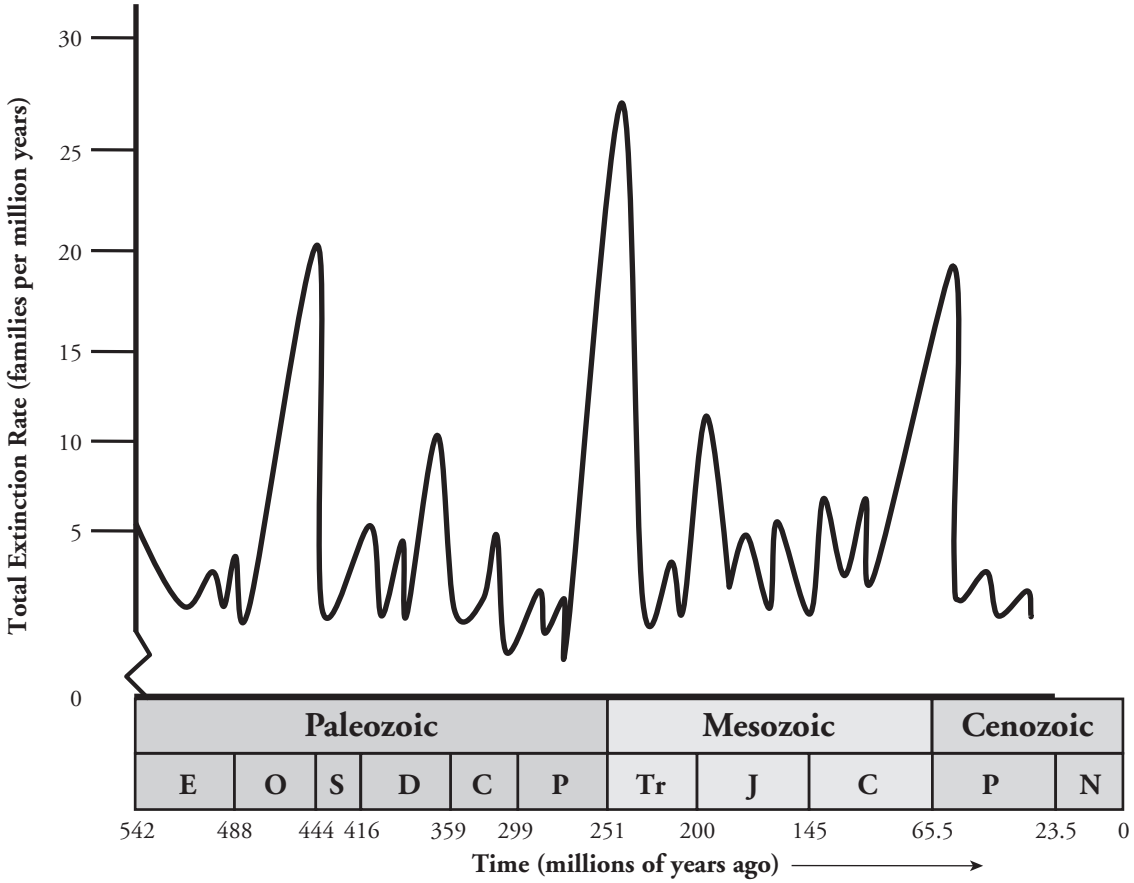
Mass Extinctions

What is the biological significance of mass extinctions?

Why?

Evidence suggests that five mass extinctions have occurred throughout the history of the Earth—the most famous of which led to the extinction of the dinosaurs. Scientists are still studying the causes of these catastrophic events. What can we learn from mass extinctions, and what is their impact on the diversity of life forms found on Earth?

Model 1 – Extinction Over Time



1. What are the names of the three eras identified on the *x*-axis in Model 1?

2. To what does the *y*-axis on the graph in Model 1 refer? (Include the unit of this variable.)

3. According to Model 1, approximately how long did each of these eras last?
   a. Paleozoic
   b. Mesozoic
   c. Cenozoic

4. The letters below each era refer to discrete time periods that are listed in the table below. Complete the columns to indicate the approximate length of time each period lasted.

Era	Period	Length of time (in millions of years)
Paleozoic	Edicaran	
	Ordovician	
	Silurian	
	Devonian	
	Carboniferous	
	Permian	
Mesozoic	Triassic	
	Jurassic	
	Cretaceous	
Cenozoic	Paleogene	
	Neogene	

5. Circle the five major mass extinctions on the graph in Model 1.
6. List the period in which each mass extinction begins and ends.

   Mass Extinction 1 begins in _____ and ends in _____.

   Mass Extinction 2 begins in _____ and ends in _____.

   Mass Extinction 3 begins in _____ and ends in _____.

   Mass Extinction 4 begins in _____ and ends in _____.

   Mass Extinction 5 begins in _____ and ends in _____.
7. What appears to be one criterion that scientists use when defining the timing of geologic periods?

8. Scientists name mass extinctions using the name of the time period during which the extinction began. Using this information, with your group name each of the five mass extinctions.

9. Carefully study the graph in Model 1.

   a. The line on the graph is never flat. What does this tell you about the rate of extinctions over time?

   b. The line never reaches zero. What does this tell you?

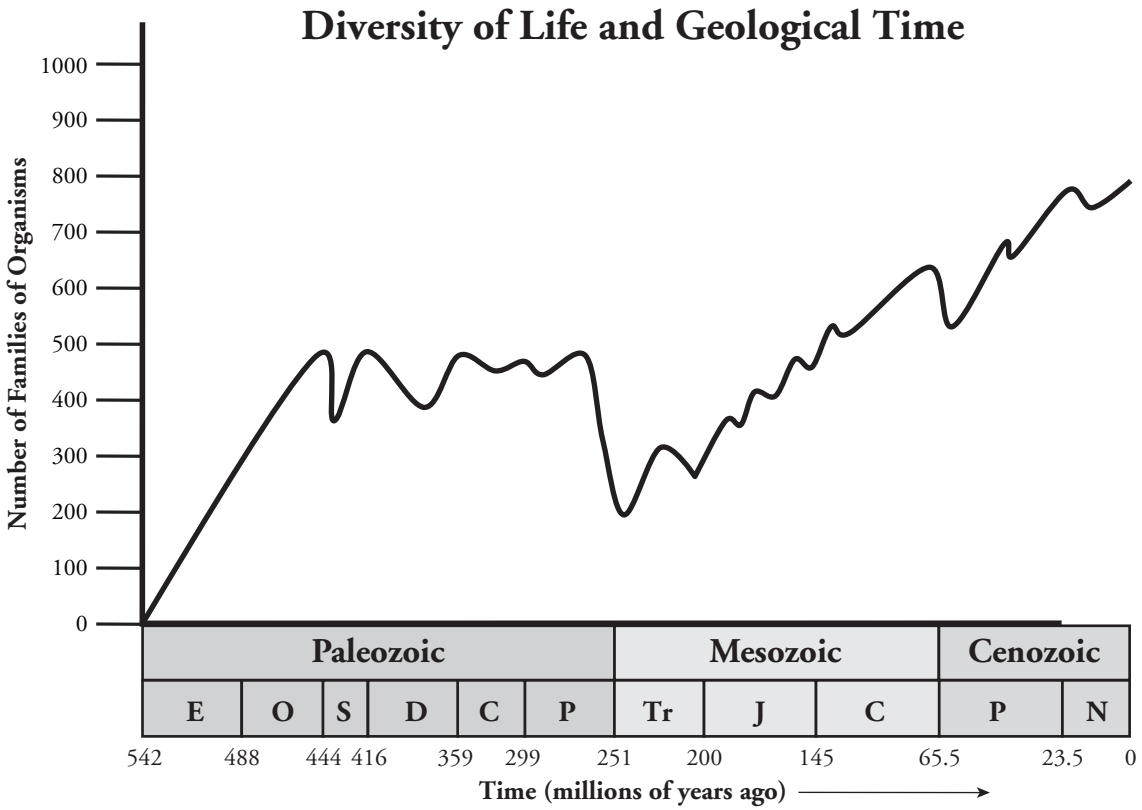
10. Species may become extinct for many different reasons. Brainstorm with your group and list five different factors that might cause a large number of species to become extinct.

Read This!

During the Permian extinction, 96% of all marine animal species became extinct. One suggested explanation for this is a series of massive volcanic eruptions that produced enough CO_2 to warm the global climate by approximately 6 °C. The leading theory for the Cretaceous extinction (which led to the disappearance of dinosaurs), is that a large extraterrestrial object collided with the Earth and resulted in a cloud of debris that disturbed the global climate.

11. Look at your group's answers to Question 10. Were any of the explanations given in the *Read This!* box also on your list? If not, add them now.

Model 2 – Diversity of Life



12. How is the dependent variable in Model 2 different from that in Model 1?

13. What is the overall trend shown in the graph in Model 2?

14. The number of families of organisms is an indicator of **biodiversity**. Looking at the graph, what can you conclude about the biodiversity on Earth over the time period shown?

15. On the graph in Model 2, mark the location of the five mass extinction events depicted in Model 1 with arrows.

16. What is the *immediate effect* of mass extinctions on the number of families of organisms?

17. Using the graph in Model 2, estimate how long it takes for the number of families to recover after a mass extinction.

Read This!

Mass extinctions leave behind niches in ecosystems that can be filled by new or existing species that exhibit adaptations allowing them to survive in those spaces. This process is called **adaptive radiation**. For example, the fossil record shows that mammals living more than 65.5 million years ago were mostly small, rodent-like, burrowing creatures without much diversity. After the Cretaceous mass extinction, however, there was a dramatic increase in the number and types of mammals.

18. Propose an explanation for why small rodents were able to survive the Cretaceous mass extinction.

19. How did the extinction of the dinosaurs allow the adaptive radiation of mammals to occur?

20. What evidence do you see from Model 2 that large scale adaptive radiation occurred following the five mass extinctions?

21. Predict what would have happened if all of the early mammals living 66 million years ago had died out in the Cretaceous mass extinction?

22. Many biologists propose that we are currently in a sixth major extinction. If this is true, this mass extinction event may be the first caused by one of the Earth's inhabitants—humans. What human actions do you think may be the cause of the increased rate of extinction today?

23. What data could you collect that would support the idea that we are currently at the start of the sixth mass extinction?

24. In light of your group's answers to the previous questions, what would you predict to be the long-term result of a sixth mass extinction?

Extension Questions

25. What is the source of the data collected to produce the graphs used in this activity?

26. Every mass extinction leads to the rise of prominence of new groups of organisms. Using resources from the Internet, research what type of organisms were dominant after each of the five mass extinctions.

Discussion Questions for PBS Endangered Species Science Trek Video

Name _____ **Date** _____ **Class** _____

1. What are some of the reasons why habitats change?

2. How have some species been saved from extinction?

3. Name an animal in Idaho that is on the endangered species list.

Name: _____ Date: _____ Class: _____

Endangered Species Research Sheet

Directions: Choose one of the five species listed below and use the readings of your selected endangered species to answer the following 7 questions on this worksheet. You will use this information to make a presentation

If you have access to the technology and internet, then you can choose one of the 30 endangered species found on this website: https://www.worldwildlife.org/

Endangered species:_____

If you have access only to the print materials, choose one of the following five

Endangered species:_____

a. Tiger
b. Black-Footed Ferret
c. White Rhino
d. Bornean Orangutan
e. Beluga Whale

Collect research about your endangered species by answering the following questions. Remember to cite all of your information!! Give credit where credit is due!

1. What is the common and scientific (Latin) name of the plant/animal?

2. What does the organism look like? Be specific about variations in size, shape, color etc. Include a photo. Remember to give credit if you attach a photo to the location of the original photo (such as wikipedia)

3. Where does it live, what is its natural habitat? Be descriptive and include a map that shows its current range and its previous range.

4. What does it eat? What is its role in the ecosystem? What other organism will be affected if it becomes extinct?

5. What are some adaptations of this organism that make it unique?

6. Describe the causes of endangerment/threats. Why is this organism endangered? Who/what is responsible for the decrease in numbers. Is there any criminal activity associated with this organism?

7. Propose ways that the animal can be helped, include any laws or projects that are already in existence to help the animal. Include a reward and why your species should be helped.

As you design your publication, imagine that you want to convince others to donate to the cause or help the animal in some way. Treat it like a persuasive essay. Your goal is to get people interested and to get them involved.

How Will You Present Your Information?

Pick one of the three ways to complete and turn in your project. Your publication should be created digitally or paper poster so that it can be shared with others.

1. **Build a Website:**

Weebly.com : this is a very easy way to build a website, with a drag and drop application. You will need to create a new, free account to build the website.

2. **Create a Presentation**

Microsoft Office : use your Microsoft 365 Team to create a powerpoint that can be stored, shared, and published onto your Team account for me to grade. You will need at least seven slides for each question that you did on your Research Sheet for your endangered species.

3. **Create a Poster**

If you do not have a computer, you can still do the project on a piece of paper or even posterboard using the instructions below. Take a picture of your paper project and upload it to your assignment tab on my Team.

Instructions/Rubric for Poster:

Your product should contain the following information. You are also free to include any other interesting information that is relevant to your animal.

- NAME / ALSO KNOW AS (latin name / common name)
- PICTURE – a drawing
- IDENTIFYING CHARACTERISTICS – key features to look for when identifying this species
- LAST SEEN – where does this organism live? Give its previous range & its current range. Include a map (Extra Credit).
- THREATS- Why is this species almost extinct? Explain the nature of the “criminals” that have affected this species.
- WHY IT’S SPECIAL- Include adaptations of the species and its specific role in the ecosystem. What other organisms will be affected by the extinction of your species? What does it eat, how does it fit into the food web of the ecosystem?
- REWARD for finding helping preserve this species. (think ecologically, economically, socially, politically – again, be specific for your species)
- Color, neatness, and creativity!
- All information must be in your own words. Spelling counts!
- Bibliography –PROPERLY FORMATTED (do NOT just list websites) on back of poster board

Endangered Species - PROJECT RUBRIC Name:

CATEGORY	5 pts	4 pts	2 pts	1 pts	0 pts
Coverage of the Topic	Details on the presentation capture the important information about the topic and increase the audience's understanding.	Details on the presentation include important information but the audience may need more information to understand fully.	Details on the presentation relate to the topic but are too general or incomplete. The audience needs more information to understand.	Details on the presentation have little or nothing to do with main topic.	No Attempt
Use of Graphics	All graphics are related to the topic and make it easier to understand.	All graphics are related to the topic and most make it easier to understand.	All graphics relate to the topic.	Graphics do not relate to the topic.	No Attempt
Organization	Information is very organized with clear titles and subheadings.	Information is organized with titles and subheadings.	Information is organized, but titles and subheadings are missing or do not help the reader understand.	The information appears to be disorganized.	No Attempt
Layout and Design	All information on the presentation is in focus and can be easily viewed and identified from 6 ft. away.	Most of the information on the presentation is in focus and the content easily viewed and identified from 6 ft. away.	Most of the information on the presentation is in focus and the content is easily viewed and identified from 4 ft. away.	Much of the information on the presentation is unclear or too small.	No Attempt
Sources	All sources (information and graphics) are accurately documented.	All sources (information and graphics) are accurately documented, but there are a few errors in the format.	All sources (information and graphics) are documented, but information is incomplete or many are not in the desired format.	Some sources are not accurately documented.	No Attempt
Mechanics	No grammatical, spelling or punctuation errors.	Almost no grammatical, spelling or punctuation errors	A few grammatical, spelling, or punctuation errors.	Many grammatical, spelling, or punctuation errors.	No Attempt
Presentation	The presentation was the appropriate length. It did not seem hurried or too slow. The presenter spoke clearly and distinctly and established eye contact with the audience.	The presentation was the appropriate length but seemed slightly hurried or too slow. The presenter spoke clearly most of the time and established eye contact with the audience.	The presentation was the appropriate length but seemed very hurried or too slow. The presenter spoke clearly and distinctly only some of the time and/or established little eye contact with the audience.	The presentation was too long or too short. The presenter did not speak clearly most of the time and established little eye contact with the audience.	