

# Impacts

## Extra Credit:

Create a narrative with appropriate figures/tables describing how projected climate change will influence one aspect of the environmental "status quo" in the State of Maine. Your narrative may include web links and must include appropriate references. Only one student per topic, claim your topic in the table below:

Name	topic (try to be very specific)
Sarah	Impact of sea level change on the ecology of the Maine coast
Julia	Impacts on Maine horticulture
Dan H.	Mercury levels in Maine Lakes
Rob D.	Impacts on Tree Declines
Elissa	The impact of climate change on Maine insects and the resulting effects on plants, trees, etc
Brian	Impact of climate change on marine resources (particularly lobster)
Katie	Impact of Climate Change on Ice-Out Dates and Stream Flow
Brittany T.	Impact of climate change increasing lake temperatures, which impacts the amount of dissolved gasses and minerals
Lane	Impact of climate change on tourism in Maine
Sharon	Impact of climate change on populations of Atlantic salmon
Jason	Impact of climate change on gaming/hunting in Maine

expand table as needed.

example topics: sealevel rise, changes in stream flow, etc. (A good place to start: <http://www.climatechange.umaine.edu/Research/MaineClimate/index.html>)

## Start Narratives below:

### Sarah Bartels: Sea Level Change

A rise in sea levels is projected to occur due to global warming melting glaciers and ice caps, as well the fact that warm water takes up more space than cold water. The 2007 IPCC found that "since 1961 the average temperature of the global ocean has increased to depths of at least 3000 m and that the ocean has been absorbing more than 80% of the heat added to the climate system." This warming, as previously stated, has caused seawater to expand and sea levels to rise. According to the EPA's 1998 paper Climate Change and Maine [[http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BUT6R/\\$File/me\\_impct.pdf](http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BUT6R/$File/me_impct.pdf)], sea level is projected to rise by 6-38 inches along Maine's coast by 2100, and this rise in sea level could cause flooding of property along Maine's 3,500 miles of tidally influenced shoreline. It could also cause loss of coastal wetlands, contamination of drinking water, and beach erosion. Currently, the tides are increasing, and Joseph Kelly, a UMaine professor and member of the climate institute claims that the tide guage at Rockport has shown sea levels rising 2 mm a year. Clay cliffs are also eroding and falling into the sea, putting homeowners living there at risk. This link shows a figure from the Maine Geological Survey on sea level rise in Portland, Maine [<http://maine.gov/doc/nrimc/mgs/explore/marine/firms/images/firms-2.htm>]

This predicted rise in sea level would also impact sand dunes and wetland systems that serve to protect the coast and terrestrial systems from the sea. The Maine coast contains many high value, nationally significant marine habitats that could be significantly affected by accelerated sea level rise. Wetland systems, marshes, and dunes are also important breeding habitat for many species including the endangered Piping Plover,

Saltmarsh Sparrow, and Roseate Tern. Accelerated rise in sea levels would inundate coastal marshes and wetlands, especially in areas where they are already constrained by development. In many areas, marshes will disappear or, if not hindered by geography and development, be pushed further inland.

In 2006, the Natural Resource Council of Maine assessed the potential impacts of climate change on Maine's coast, and identified communities most at-risk from sea level rises [http://www.nrcm.org/sea\\_level\\_rise\\_maps.asp](http://www.nrcm.org/sea_level_rise_maps.asp). Should sea levels rise the projected 2-3 feet in the next century, whole roads such as Route 1 would need to be rerouted and rebuilt. The impacts on those living in at risk area would be enormous, as well as the impact to the tourist areas along the coast. Tourist towns along the coast could suffer a collapse of the local economy due to their reliance on beach related activities and tourism. Services such as sewer treatment and stormwater drainage could also be affected by sea level change, especially discharge points.

Other References:

Maine Bureau of Air Quality. *Global Climate Change*. <http://maine.gov/dep/air/globalwarming>. 2008.

EPA Office of Policy, Planning and Evaluation. *Vulnerability of Maine Sites to Accelerated Sea Level Rise*. 1995. [http://yosemite.epa.gov/oar/Glob alWarming.nsf/UniqueKeyLookup/SHSU5BUSAD/\\$File/maine\\_2.pdf](http://yosemite.epa.gov/oar/Glob alWarming.nsf/UniqueKeyLookup/SHSU5BUSAD/$File/maine_2.pdf)

### **Katie Harris: Impact of Climate Change on Ice-Out Dates**

Ice-out dates are the dates in spring when winter ice cover leaves a lake. Ice-out dates can be used to measure climate variability and change. Many areas are dependent on the freezing and thawing of lakes. In the winter lakes are used for ice fishing, skiing, dog sled racing, and snowmobiling which are important for the tourism economy. The melting of lakes is important in the transportation industry. Changes in ice-out dates can have major effects on lakes such as the rate of change of summer oxygen levels as well as the health of important parts of the food chain. Between 1850 and 2000 ice-out dates in northern New England have been earlier by 9 days. This is suggesting that spring is coming sooner and accounts for the 1.5°C increase in temperature. This climate change is expected to cause a decrease of cold water habitats, a reduction of dissolved oxygen, reduced lake levels, changes in lake mixing, and altered nutrient cycles.

Ice-out dates can also have an effect on stream flow timing and volumes. Stream flow data have indicated that stream flows have increased in winter and early spring and decreased in late spring and early summer. However, there were no significant trends in annual total stream flow. Trends indicate that the last day of ice affected flow in the spring is earlier and there are fewer total days of ice affected flow. Later freezing and earlier melting contribute to the significant decrease in ice affected flow in four of the five coastal rivers in Maine from the study.

[<http://pubs.usgs.gov/fs/2005/3001/>  
<http://pubs.usgs.gov/fs/2005/3002/>  
<http://www.gulfofmaine.org/times/summer2004/scienceinsights.html>

Contains data for the ice-out dates for 29 lakes in New England from 1800-2000:  
<http://me.water.usgs.gov/reports/OFR02-34.pdf>

Graph of the trends in ice out dates for lakes in New England from 1925-2000:  
<http://www.climateandfarming.org/pdfs/FactSheets/1.2Indicators.pdf>

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### **Brian DiMento: Impact of Climate Change on Marine Resources**

Climate change will potentially exacerbate the stress put on marine organisms by human harvesting and other anthropogenic activities. Fishing has played a crucial role in both the culture and economy of Maine. Many coastal communities are closely tied to species such as cod and the iconic lobster. Revenue from lobsters is in the hundreds of millions of dollars, coming from several thousand lobstermen on Maine waters. The state of Maine is responsible for the more than half of the total annual U.S. landings. Lobstering provides a unique way of life for many living in the fishing villages along Maine's coast.

Of the added heat from global warming, 80% resides in the ocean. In southern New England and the Mid-Atlantic States, increasing water temperatures over the past decade have been attributed to sharp declines in lobster landings. A temperature of 20°C was established as a critical threshold, and it has been exceeded often during the summer in these areas. Living at high temperatures is difficult for lobsters due to the stress put on them because of the decreased solubility of oxygen. The occurrence of the molting cycle during the warmer months also results in lower resistance to these stressful conditions. While this drastic decline in the southern lobster fishery led to many hardships on the local fishing industry, a different circumstance is likely in the northern waters such as the Gulf of Maine. While the temperatures are still increasing here, the predicted scenario involves a potential for increased lobster productivity. This result would be due to an increased amount of thermally suitable habitat, providing the same climate-induced changes do not have other negative effects on the same system. In fact, lobster landings in the U.S. have nearly tripled over the past two decades. This increase can be explained by a combination of increased effort and technology, as well as favorable water temperatures in the most popular fishing areas. Also contributing is a decrease in predatory fish populations, namely cod.

While the water temperature increase is favorable for lobsters in Maine, it is not favorable for cod. Landings of Cod in the Gulf of Maine have declined drastically due to intensive exploitation, as well as environmental changes. Increases in water temperatures result in a decline in the number of surviving young entering the fishery (recruitment), thus lowering the future population.

Another important factor in addition to water temperature is water acidity. Excess carbon dioxide absorbed by the ocean results in increased acidity of the water (carbon dioxide combines with water to form carbonic acid and other acid-base products). This acidification harms the

shell-forming lobster.

In conclusion, while the largest effects on marine resources are due to human influences such as over-fishing, climate change is also affecting the "status quo" of Maine fisheries and the populations they rely on. In the case of the lobster, declining populations in one area may correlate with increasing populations in another.

Figures (from [http://64.233.169.104/search?q=cache:AeWaj6MTPd4J:www.northeastclimateimpacts.org/pdf/miti/fogarty\\_et\\_al.pdf](http://64.233.169.104/search?q=cache:AeWaj6MTPd4J:www.northeastclimateimpacts.org/pdf/miti/fogarty_et_al.pdf)):

Figure 9 (page 17) depicts the parallel of water temperature and landings of lobster over the last century, while Figure 13 (page 23) shows the same relationship in regards to cod.

Figure 10 (page 18) depicts the abundance of lobster, while Figure 14 (page 24) shows the abundance of cod.

References:

<http://www.whoi.edu/page.do?pid=8915>

[http://64.233.169.104/search?q=cache:AeWaj6MTPd4J:www.northeastclimateimpacts.org/pdf/miti/fogarty\\_et\\_al.pdf](http://64.233.169.104/search?q=cache:AeWaj6MTPd4J:www.northeastclimateimpacts.org/pdf/miti/fogarty_et_al.pdf)

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Jason Hine- climate change effect on gaming in Maine

Like the rest of the world, as Maine's climate begins to change, the state will experience drastic transformations. This is no less true for the world of hunting and gaming in Maine. While certain species become more scarce others will begin to be seen with more prevalence. For instance, perhaps the most noted animal of Maine's gaming world, the moose, may no longer be huntable in Maine. Increasing temperatures has driven moose north into Canada. The decline of pine forests and shifts in forest type eliminates a major component of moose and other Maine animal habitat. To exacerbate the population decline, a number of parasites previously unknown to Maine have taken up residence here in light of the warmer weather. Wally Jakubas, the mammals group leader for the Maine Department of Inland Fisheries and Wildlife, says that a major contributor to moose decline presently and in the future are dog ticks. Last fall's moose hunt proved this to be true. Jakubas noted that it was commonplace to see a moose covered with over 100,000 dog ticks. "It is scary how these insects can remove more protein than a moose can take in," Jakubas noted. Moose are not alone in this parasite infestation. White tailed deer, black bear, etc are likely to suffer similar declines. Another parasite seen in growing numbers throughout Maine is the mosquito. Researchers have noticed the introduction of the japonicus mosquito, a known carrier of a number of diseases including West Nile. Other species, while presented with the above problem, face other challenges. Lynx are seen to be more successful hunters in deep snow. As snow levels decrease throughout Maine, lynx will experience a population decline as animals move northward or die out.

Other problems for Maine's gaming species include the invasion of previously foreign species (including the talked-about parasites). Southern-residing species have moved north in light of warmer weather. The grey fox, previously only found in southern Maine, has been seen as far north as Augusta. As these species move north, they create competition for the naturally found animals. This further facilitates the movement of Maine's resident species northward.

Collectively, the climate change can potentially have drastic impacts on Maine's game species. As the environment around them changes, they experience problems such food scarcity, invasive parasites, and competitive foreign species. In future years, Maine hunters may see animals more common to present day Connecticut than their prized moose or black bear. sources:

<http://bangornews.com/news/t/news.aspx?articleid=150974&zoneid=500>

<http://www.climatechange.umaine.edu/Research/MaineClimate/Insects.html>

[http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BUT6R/\\$File/me\\_impct.pdf](http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BUT6R/$File/me_impct.pdf)

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### **Dan Heinrich - Mercury Levels in Maine Lakes**

The level of mercury (Hg) in MaineLakeshas become a serious issue over the last 50 years. This has been a direct effect of Hg emissions, pollution, and dumping into lakes and streams. There has been a steady increase of Hg atmospherically deposited levels found in the Caribou Bog in Orono,Maine, as shown here: <http://www.climatechange.umaine.edu/Research/MaineClimate/Lakes.html>. Right around the industrial revolution, Hg levels began to rise, and around the 1950's, the Hg levels increased dramatically. Around 1970-1980, the government identified and reduced the amount of pollution allowed, and a decrease in mercury levels was seen.

But, even with reduced pollution and dumping into streams, Hg levels are still very high in MaineLakes. A recent study by the Environmental Protection Agency showed that every single fish found in MaineLakes had some form of contamination from Mercury. 89% of the fish tested had Hg levels that exceeded what was considered safe to eat for women of child bearing age! When this data was presented to the President Bush, he added something to the Clean Air Act, which was mercury emission reduction. This is a step in the right direction but the government plans on implementing this policy in 2018. If Hg levels are still rising, this is an immediate problem. According to Eric Bourassa, once mercury is released, it doesn't go anywhere: "Fish just get higher and higher levels of it. We're looking at an average of 0.5 parts per million now in Maine. In 10 years, we could see up to 0.75 parts per million." We are looking at higher and higher levels of mercury, while the EPA suggests that the tolerable threshold is recommended at 0.13 parts per million!

As much as Hg levels can contribute to health risks, it also threatens businesses, restaurants and grocery stores across the state that rely on fishing. Sport fishing contributed \$250 million to Maine's economy last year, and is one of Maine's leading incomes.

So mercury levels are becoming more and more recognized, but what exactly are its impacts on the human body? Most of the more

serious effects of mercury are from inhalation in the workplace and prolonged exposure to mercury, but there are still negative effects from eating fish with high levels of mercury. Mercury's effect on the body can increase blood pressure or heart rate, decrease the effectiveness of the body's immune system, increase the sensitivity of one's skin, and many other effects. Most of these symptoms will not be apparent unless the dosage is high enough, but with mercury levels rising in fish, this potentially could be a problem we will see in the near future.

Although our government is slowly working on Hg emission reduction, this is a problem that needs to be dealt with immediately. Anyone who eats fish or seafood should be wary of the potential for mercury poisoning.

Sources:

<http://www.climatechange.umaine.edu/Research/MaineClimate/Lakes.html>

[http://www.ccohs.ca/oshanswers/chemicals/chem\\_profiles/mercury/health\\_mercury.html#\\_1\\_4](http://www.ccohs.ca/oshanswers/chemicals/chem_profiles/mercury/health_mercury.html#_1_4) <http://environmentmaine.org/envmaine.asp?id2=14774>

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### **Effect of climate change on forest decline and destruction - Rob Dillon**

Climate change will have a very significant effect on the health and composition of Maine's forests. As global temperatures increase, ecosystems will start to migrate further north to follow the changing climate patterns. Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. If conditions also become substantially drier, the current range of forests could be reduced and replaced by grasslands and pasture. Trees that are better adapted to warmer conditions would replace the current species. Under these conditions, forests could become more dense. These changes could occur within the next few decades according to present emissions projections, particularly if the change is accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

The spruce-fir forests in Maine (and other New England states) are near the southern limit of their extent. These forests are sensitive to climatic stresses and have experienced significant declines in recent decades. This could be detrimental to the logging industry in the state of Maine. Some of the following examples could cause a lot more economic trouble for Maine, a state that relies heavily on its wood resources.

"A few examples: Maple sugar businesses could dry up over the next 50 years, as the familiar hardwood stands of maple and birch in western Maine give way to oak and hickory. Sawmills in York and Cumberland counties could scramble for high-value white pine, as the species is replaced by loblolly and southern pines. Paper and lumber mills that depend on the vast spruce-fir resource of northern and eastern Maine would have to adapt to a forest of oak and pine."

Sources:

<http://business.maintoday.com/news/070304climatechang.html>

[http://www.sallan.org/pdf-docs/Maine\\_Forests.pdf](http://www.sallan.org/pdf-docs/Maine_Forests.pdf)

<http://www.climatechange.umaine.edu/Research/MaineClimate/index.html>

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### **Julia Coffin- Impacts of Climate Change on the Horticulture Industry in Maine**

*"In the state of Maine, a recent economic survey showed that Maine horticulture (not including the turf industry) generated over \$286 million sales per year with 88% of that revenue received by Maine-based companies. Maine horticulture includes over 750 firms, employing more than 10,000 Maine citizens. The industry keeps over 13,000 acres in agricultural production and generates \$20 million in taxes"* ([http://www.nsf.umaine.edu/WhitePaper/Horticultural\\_Industry.pdf](http://www.nsf.umaine.edu/WhitePaper/Horticultural_Industry.pdf))

The climate been changing in Maine, over the last century the average annual temperature has increased by 3.4°F in Lewiston. A long-term change in Maine's climate will have serious effects on the horticultural crops grown in our state. Climate change will alter the hardiness zones throughout the state (click to see zoning in Maine: <http://www.climatechange.umaine.edu/Research/MaineClimate/Horticulture.html> ). Hardiness zones are geographically defined as a measure of a plant's ability to withstand life in the defined area at the average annual minimum temperature. Basically the USDA came up with a system for horticulturists to use to determine which plants will be able to survive in different climate areas, a plant is considered hardy if it can survive in cold temperatures. An increase in the climate would allow cultivators in Maine to introduce new, less cold hardy plants, leading to an increase in plant diversity in Maine. However this could lead to a decrease the need for certain species to be grown in nurseries.

This increase in temperature would not necessarily provide a better climate for plants to thrive in Maine; some plants require a long period of vernalization in order to be successful. Vernalization is requirement of many species of temperate plants, it is defined by Wikipedia as a period where the plant must experience low winter temperatures to accelerate the growth process in the spring. Some species even require these low temperatures to break dormancy and initiate growth (<http://en.wikipedia.org/wiki/Vernalization>).

The increase in the average annual temperature would predictably increase the length of the growing season. This can have both positive

and negative effects. The positive effects would be some plants could be more successful by producing bigger plants or more fruit, and the growers could sell products earlier. Greenhouses would also need less fuel for heat, which could reduce costs and the carbon footprint. However it is also important to weigh the negative effects such as the increase in the amount of fertilizer and water commercial farmers would potentially use, resulting in more fertilizer in the ground water which has severe environmental side effects.

Overall it has been estimated by EPA that climate change will have a significant effect in crops in Maine. The two major crops in the state are potatoes and hay, the figure on page three of this pamphlet shows the decrease in production with a 4 degree increase in temperature in conjunction with a decrease in precipitation ([http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BUT6R/\\$File/me\\_impct.pdf](http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BUT6R/$File/me_impct.pdf)). This decrease in production and yield may not be as bad as it looks, because the increase in the growing season could provide an opportunity for farmers to alter their cultivation practices limiting monetary losses.

Sources:

[http://www.nsfa.umaine.edu/WhitePaper/Horticultural\\_Industry.pdf](http://www.nsfa.umaine.edu/WhitePaper/Horticultural_Industry.pdf)

<http://www.climatechange.umaine.edu/Research/MaineClimate/Horticulture.html>

<http://en.wikipedia.org/wiki/Vernalization>

[http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BUT6R/\\$File/me\\_impct.pdf](http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BUT6R/$File/me_impct.pdf)

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### **Sharon Fuller- Impact of climate change on populations of Atlantic salmon**

Salmon are a good indicator of climate change as they have been well-studied, they spawn in fresh water (which is likely to experience the effects more quickly than oceans, which are large and can act as a buffer), and they encounter a range of habitats, any or all of which can be effected by climate change. Atlantic salmon, which spawn in many of Maine's rivers, are of particular importance as they have become an endangered species in the past few decades. Their life cycle consists of incubating in the winter and hatching in the spring in fresh-water rivers, developing in part in the river, traveling to the ocean for a period of growth for the majority of their lives, then returning to their river of origin to spawn a new generation.

Alteration of water temperature can have many effects on salmon, particularly on their growth and development. Warmer winters than are typical can cause premature hatching and high levels of juvenile mortality, as development is greatly dependent on temperature. The effects continue throughout the life of the Atlantic salmon, as this species has a narrow range of optimal feeding temperatures. Although increased temperature may increase the growth rate in northern regions due to the extended growing season, the introduction of unpredictable droughts can serve to destroy habitat and reduce food sources.

As a cold-blooded species, salmon's metabolic rate increases greatly at warmer temperatures. This may cause the animals to avoid areas of warm water created by climate change. The warmer water also increases the occurrence of pathogens. Climate change is also predicted to reduce river flows, which may disrupt migration patterns. In all of these ways, climate change serves to threaten this species that already has been greatly reduced in number by various other anthropogenic forces.

#### **Sources:**

Fleming, I.A. & Jensen, A. J. (2002) Fisheries: Effects of climate change on the life cycles of salmon. *Causes and consequences of global environmental change* **3**, 309-312.

Swansburg, E., Chaput, G., Moore, D., Caissie, D., El-Jabi, N. (2002) Size variability of juvenile Atlantic salmon: links to environmental conditions. *Journal of Fish Biology* **61**, 661-683.

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Brittany Tschaen

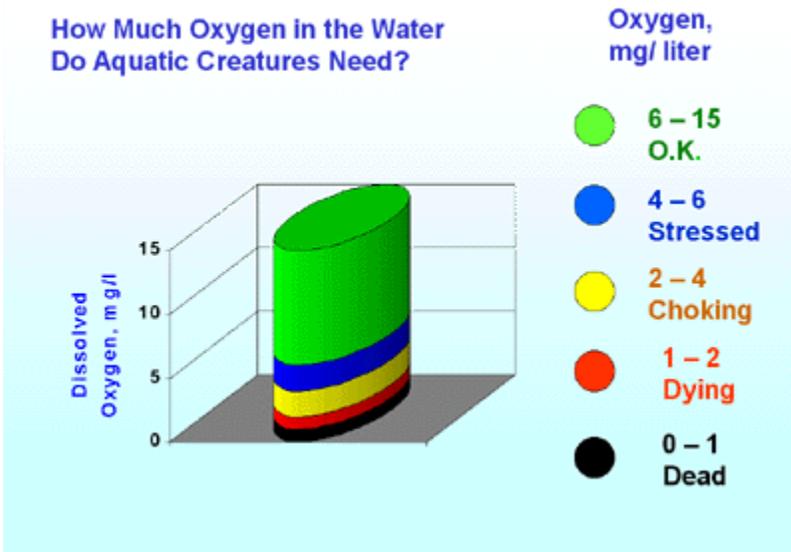
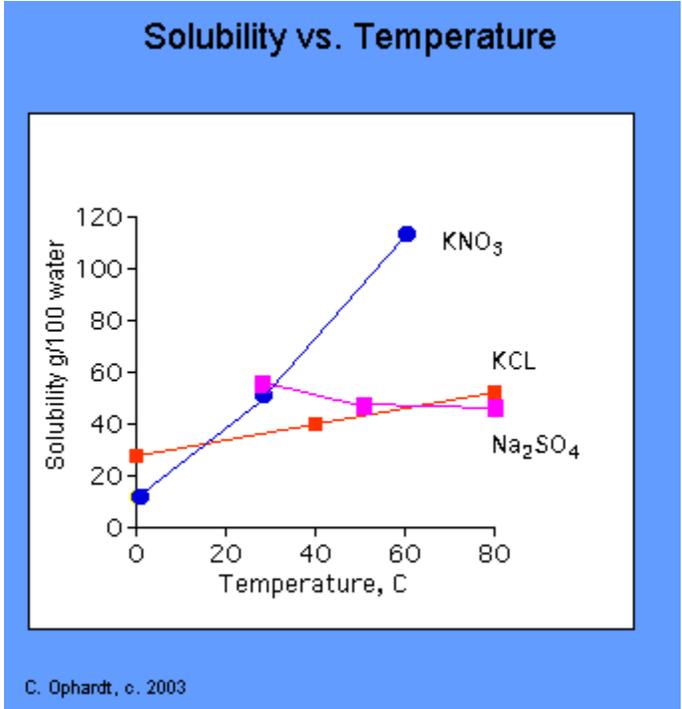
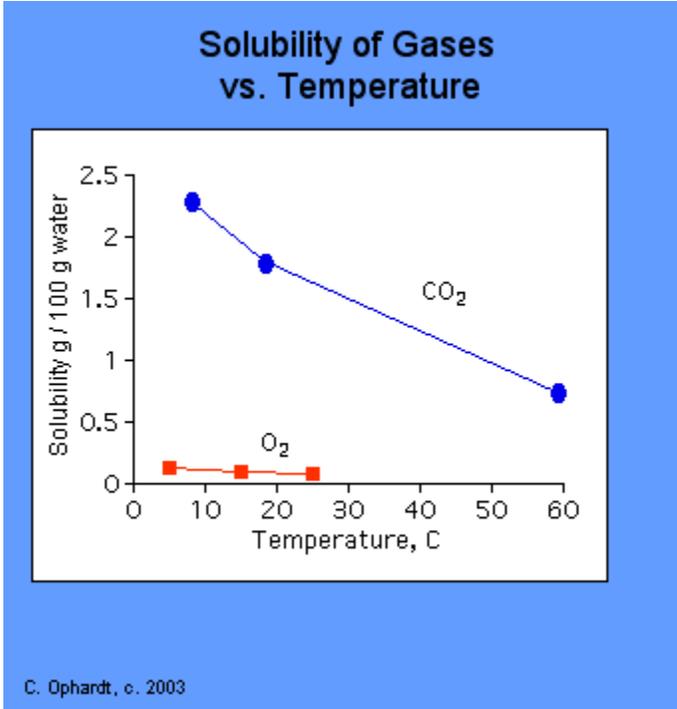
#### **The Effects of Temperature on the dissolved gases and living organisms**

The climate change in Maine causes many different problems in the lakes that are all connected. Several of the problems are linked to the increased lake temperature. Global warming is predicted to warm lakes on average 2- 4 degrees Celsius. This increase will change the content of the lakes. As temperature increases, the solubility of gases decreases. In order for the gases to be released, the intermolecular bonds must be broken. When the temperature of the lake increases, the kinetic energy also increases which is the source of energy needed to break the bonds. As a result the gases are released into the atmosphere. Below is a graph that expresses the relationship between dissolved gases in respect to the temperature. A chart that represents the dissolved oxygen levels at varying temperatures can be found at <http://www.epa.gov/volunteer/stream/vms52.html>.

On the other hand the ionic compounds become more soluble as the temperature increases. The increase in the amount ionic compounds that are dissolved in the water, also cause the gas solubility to go down. This is because oxygen is used to decompose these compounds. As the temperature increases and the amount of sunlight that hits the surface of the water also increases, the algae are able to flourish. Since the amount of ionic compounds that are able to dissolve is increased, more phosphorus will be available. The amount of phosphorous is one of the main limiting factors for algal growth. This situation leads to what is known as an algal bloom. When the algae die, it becomes food for the

bacteria to complete decomposition. During this time large amounts of the dissolved oxygen is used up and when the oxygen is depleted living organisms can no longer survive. The amount of oxygen used by the bacteria is referred to as the biological oxygen demand (B.O.D.). Below is a graph that expresses the relationship between ionic compounds in respect to the temperature.

The aquatic living organisms require dissolved oxygen in the water to survive. Aquatic organisms require the oxygen for respiration and the lack of oxygen puts a large amount of stress on the organisms. In order to support living organisms, the amount of dissolved oxygen in a lake must be greater than the biological oxygen demand. Below is a graph that estimates the correlation between the amount of dissolved oxygen and the effects it has on the living organisms.



**Lane Mahoney: Impact of Climate Change on tourism in Maine**

Tourism is very important for Maine's economy. The money spent by tourists generates jobs, incomes and tax revenue. In 2006 the Maine State

Planning Office found that tourism produced \$10 billion for the state as well as 140,000 jobs and \$3 billion in earnings. This means that tourism accounted for one in five dollars in sales and supported one in six jobs in Maine. Maine has the largest percentage of jobs supported by tourism at 17%. With such a large impact on the economy of Maine, it is important to understand how climate change could affect this industry. After researching different sources I found opposing opinions on the impact climate change could have on the state of Maine's environment and consequently on tourism in Maine. I found some sources that claimed that climate change resulting in a warmer climate for Mainewould have a positive impact on tourism while I found other sources that claimed climate change would have a negative impact. These arguments are summarized below.

	Positive Impact	Negative Impact
<b>Summer</b>	? Maine is seen as a place to escape heat and humidity. Since all temperatures will be rising, Maine will still be cooler in comparison.? With warmer temps Maine could expand its tourism season into the "shoulder months" of May to mid-June and mid August to October when traditionally it is too cold.	? Climate change has caused a rise in sea level that could result in the loss of coastal lands and beaches that Maine relies on for summer tourism. Areas that would be affected are some of the most important for Maine tourism and could result in a loss of \$3.5 billion.? Rising temperatures could cause algal blooms that could cover Maine lakes that are important for tourism.
<b>Winter</b>	? Rising temperatures will result in a decrease of snowfall but only in the southern part of the state. Activities like skiing and snowmobiling could be moved further north and would generate revenue for this part of the state.? More southern states such as NY and PA would no longer produce enough snow to attract tourists that they normally would have. This could result in an increase in winter tourism as tourists would have to go further north to Maine to get to snow.	? Warming of the earth causes winter to come later and later, making the ski and snowmobile season shorter. This also causes ski resorts to rely on snow-making machines which are expensive to run and emit greenhouse gases, making the situation worse. ? The shorter season would not only affect ski resorts but also local hotels, restaurants, stores and gas stations that rely on tourist business.

Sources:

<http://www.state.me.us/spo/economics/tourism/tourism.htm>

<http://mainegov-images.informe.org/spo/economics/docs/tourism/brochure-feb-08.pdf>

[http://www.nrcm.org/news\\_detail.asp?news=936](http://www.nrcm.org/news_detail.asp?news=936) [http://scienceline.org/2007/06/20/environment\\_moser\\_ipcc\\_winter\\_tourism/](http://scienceline.org/2007/06/20/environment_moser_ipcc_winter_tourism/)

### Elissa Teasdale: Impact of Climate Change on Insects

The impacts on insects in Mainedue to the projected increases in annual temperature are expected to include both physiological and ecological effects on species. As climate conditions continue to change through the years, ecosystems and biodiversity within each also change. Species that have previously thrived in Maineconditions could be in danger, while other species which thrive in warmer temperature areas have the potential to establish populations here if the warming trend continues. New resources and natural enemies could result from this, effecting the insect populations in Maine. A matter of fractions of degrees could impact insects and thus all other species related to them. According to Wardle (1999) in *Biodiversity, ecosystems and interactions that transcend the interface*, invasions of organisms into new habitats is an extremely important component of global change in all domains whether they are terrestrial or marine based.

Temperature directly affects development, survival, range, and abundance of insect species as well as the plants and/or other species in which their survival depends upon. Interacting species likely respond differently to warming and thus when one species is disrupted, the other one is in turn directly affected. Temperature is identified as the dominant abiotic factor directly affecting herbivorous insects. Mortality of some species may be reduced in the winter months and increased in the summer months because of heat stress and desiccation. More specifically focusing on plant-insect interactions, as climate change occurs plants face high amounts of external stress, which can affect their survival rate and cooperative interactions with insects. There is a tendency for increased susceptibility of plants to insects and the diseases they transmit under changing conditions that create stress on the plant.

A feedback loop is a prime example of how one change in an insect or plant species could have significant results in the rest of the ecosystem. For example, if one kind of insect in Maineis no longer able to survive after warming due to desiccation in the warmer summer months, the plant in which they feed on would have the potential to become more abundant and fill various niches. As this plant becomes more abundant, it would also have the potential to become an invasive species, or pest, and out-compete other plants in the area in which other insects depend on. If a prey species has even a small increase in the number of generations per year due to warmer weather increasing reproductive

success, the predation will increase. Everything in an ecosystem is interrelated and if one part changes without the other having the time to create a proper defense mechanism, it will be essentially thrown off.

Overall, as temperatures rise it is predicted that there will be an increase in the overall diversity of insect species with concurrent losses in local endemism. Insecticides may become less effective due to a quicker evolution of resistance by the insects because of more pest generations created annually. Plants we depend on could also be affected by declines in some pollinator populations of insects. However, we may also experience the establishment of new and more efficient natural enemies and pollinators. The impacts on climate change need to be looked at on a long term scale because the current ecosystems will be affected gradually through time. Sources:

<http://www.climatechange.umaine.edu/Research/MaineClimate/Insects.html>

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