Climate Change in Maryland: A Resource for Educators
Concept Development for MADE CLEAR
Draft for Review February 2012
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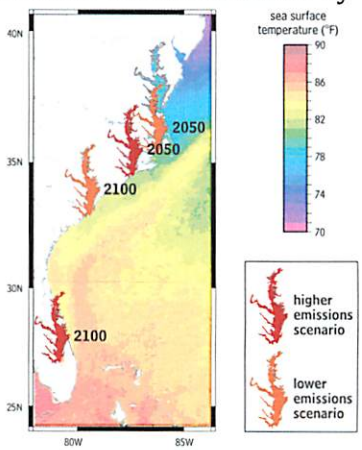
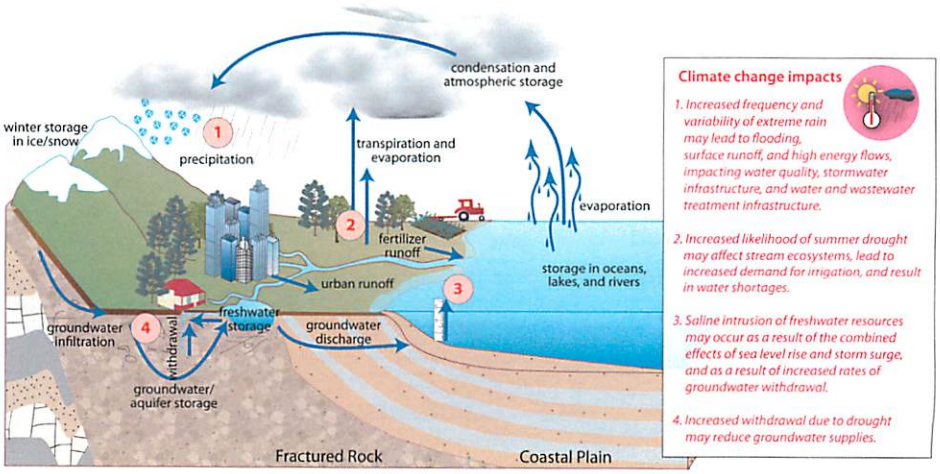
Maryland has and will experience warmer winters and summers.

- Over the past 100 years, overall average temperatures have increased by 1.8°F, while winter average temperatures have risen by 3.6°F.
- By 2100, winters are projected to warm by another 2-6°F and summers by another 3-9°F (depending on our emissions).
- By the end of 2100, the number of days exceeding 90°F is projected to double or even triple with 24 days over 100°F in a worst case scenario.
- The Chesapeake Bay has warmed by 3°F since the 1930s and will continue to warm as air temperature increases.



Precipitation has and will likely increase during the winter and spring but will decrease in the summer due to hotter temperatures.

- Over the last 100 years, average rainfall has increased in spring and autumn and decreased in the summer.
- Rainfall is projected to increase by 5-12% by 2100 with more storm events and possibly increase flooding by as much as 30%.
- Together higher temperatures and less rain will produce longer drought periods in the summer.
- Higher temperatures will also decrease snow volume by 25% in 2025 and 50% in 2100 and may increase ice storms.



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Sea level has risen and will likely continue to rise, while the waterways will be saltier, more acidic, and filled with more sediment.

- Sea level in the Chesapeake Bay has risen approximately one-foot over the last 100 years.
- Over the next 100 years, sea level is projected to rise another 2.7 feet to 3.4 feet due to climate change and land subsidence (sinking).
- This rise will increase the amount of saline water in the Bay and its tributaries. More intense storm events will increase sediment in these waterways, while higher concentrations of CO_2 will lower the pH of the ocean and possibly the Bay

Livelihoods of Maryland residents will be affected.

- **Infrastructure:** Projected rises in sea level will put 264 miles of roadway, 226 miles of rail line, and 31% of the port facilities at risk of inundation.
- **Coastal Shorelines:** Thirteen charted islands and large expanses of tidal wetlands within the Chesapeake Bay have already disappeared, and each year the State loses approximately 580 acres of land to shoreline erosion
- **Health:** Heat-related illness and death are projected to increase, especially for the poor, the elderly and urban populations. Ozone increases with temperature, so respiratory illnesses will likely increase unless air pollution is greatly reduced. Shorter winters and wetter springs may increase Increase temperature may increase disease-carrying insects like ticks and mosquitoes.
- **Crops**: Higher temperatures will lengthen the growing season by 20-40 days, which could increase crop production. However, longer drought periods will increase irrigation costs, while shorter winters and wetter springs may give weedy species and insect pests a competitive advantage.
- **Seasonal businesses:** Some businesses will be positively affected, while others will be negatively affected. For example, fisherman may lose favorite fishing holes due to higher temperatures, drought or algal blooms. Ski resorts will receive less snow and spend more on manufactured snow and may have a shorter ski season.

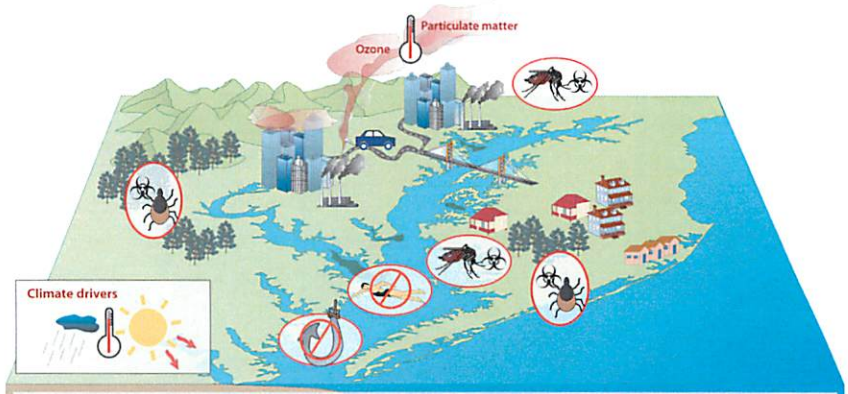

Figure 1.1: Climate drivers, such as temperature and precipitation, influence many health issues. Health issues are likely to change or become exacerbated. Among those health concerns occurring across the State are water contamination or harmful algal blooms, which prevent swimming and fishing. Increases in temperature and changes to precipitation patterns are likely to influence air quality, heat stress, and vector-borne diseases across the State.

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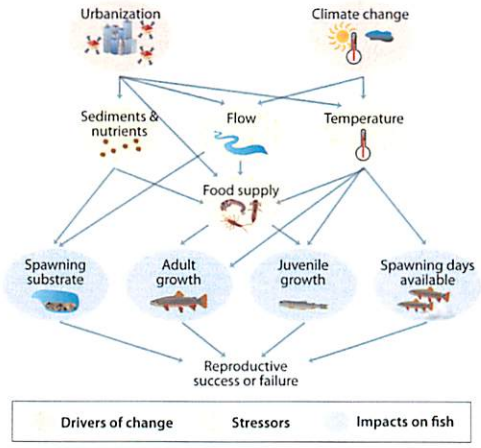
Native species composition and distributions will change leading to changes or decreases in native habitats.

- **Forests:** The maple-beech-birch forests of Allegany and Garrett counties are likely to be replaced by oak-hickory forests because the former will be less tolerant of increased temperature and drought. The oak-hickory forest type of the Piedmont and Coastal Plain west of the Chesapeake is likely to transition to an oak-pine forest because of drier soils and rising temperatures
- **Wetlands:** More droughts and warmer summers will decrease sedge/tussock meadow wetlands in central Maryland (home to the endangered bog turtle) and mountain peatland wetlands in western Maryland, (home to the southernmost larch forest). Likewise, vernal (temporary) pools will dry up earlier, eliminating habitat for wood frogs and marbled salamanders.
- **Birds:** Because of these changes in forest composition, increases in temperature and losses of wetland, some species, like the Baltimore oriole, American goldfinch, purple finch, rose-breasted grosbeak, and black-capped chickadee, will no longer be found in Maryland. Habitat change will benefit other birds, leading to larger populations of native species (tufted titmouse, northern cardinal, and indigo bunting) and exotic species.
- **Amphibians:** The Green and Jefferson Salamander may also disappear from Maryland as temperature increases.
- **Fish:** Higher temperatures will increase fish growth rates, producing smaller, less productive fish and possible mismatches with their invertebrate prey. Temperate species such as perch, striped bass, black sea bass, tautog, flounder, silver hake, and scup will be stressed by warming of the coastal waters and may move north. Species typically found south of Maryland may move north such as the atlantic croaker, black and red drum, weakfish, spotted and speckled sea trout, spot, kingfish, southern flounder, cobia, spadefish, Spanish mackerel, mullet, tarpon, and pinfish.



- **Invertebrates:** Increasingly saline waters from sea level rise will force some species to move to the upper reach of small header streams and thus increase the extinction risk of endangered species such as the dwarfwedge mussel. Higher temperatures will push the Baltimore Checkerspot (state insect) north, while its host species, the white turtlehead remains in place, hampering reintroduction efforts.
- **Iconic Bay Estuarine Species:** Increased water temperatures and sediment (from more intense storms) will likely eliminate soft shell clams and eelgrass.

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Lower ocean and Bay pH from rising CO_2 makes shell formation difficult for bay icons like crabs and oysters.

- **Algal species**: Increases in the Bay's temperature will increase populations of dinoflagellate and blue green algal species. An increase in these species, along with higher water temperatures, will increase the chance of harmful algal blooms and thus extent and frequency of dead zones in the Bay (areas with low water oxygen and light availability). This will stress and possibly reduce populations of native aquatic species

Resources

Boesch, D.F. (editor). (2008) Global Warming and the Free State: Comprehensive Assessment of Climate Change Impacts in Maryland. Report of the Scientific and Technical Working Group of the Maryland Commission on Climate Change (http://www.umces.edu/sites/default/files/pdfs/global_warming_free_state_report.pdf)

Boicourt KE and Johnson ZP (eds). 2011. Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change, Phase II: building societal, economic, and ecological resilience. University of Maryland Center for Environmental Science, Cambridge, Maryland and Maryland Department of Natural Resources, Annapolis, Maryland (http://www.dnr.state.md.us/climatechange/climatechange_phase2_adaptation_strategy.pdf)

Maryland Department of Natural Resources. 2008. Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change Phase 1: Sea-level rise and coastal storms. A report to the Maryland Commission on Climate Change from the Adaptation and Response Working Group (http://www.dnr.state.md.us/coastsmart/pdfs/comprehensive_strategy.pdf)

Web Resources:

MADE CLEAR: www.madeclear.org

Maryland's Climate Adaptation Website: www.dnr.state.md.us/climatechange/

Maryland Public Television: www.changingthebalance.thinkport.org/

Climate Literacy and Education Awareness Network: www.cleanet.org

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Feedback Request for
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Concept Development for MADE CLEAR

With funding from the National Science Foundation, the MADE-CLEAR project is exploring ways to improve and expand climate change education in Maryland and Delaware (http://www.madeclear.org/). This project is co-led by the University of Maryland System and University of Delaware. As part of the MADE-CLEAR project, we are developing a resource for K-12 and informal educators on climate change impacts in Maryland and Delaware. The included document is initial content for *Climate Change in Maryland: A Resource For Educators*. This pilot resource summarizes current and projected changes in Maryland's climate and sea level and highlights impacts of these changes on Maryland residents' livelihood and on native species. If you have any questions on this resource, please contact Marcus Griswold (Griswold@umces.edu) or Cat Stylinski (cstylinski@umces.edu).

We would like **your** feedback on our initial content for the *Climate Change in Maryland: A Resource For Educator* document. Below is a brief survey on this resource. Your participation in this project is voluntary, and you are free to withdraw at any point. Your name will be kept confidential and your privacy will be protected. All collected data will be stored electronically. Names will be replaced with an identification number, so that the source cannot be determined. There are no foreseeable risks associated with participating in this study. By completing this survey, you give consent to participate in this study.

As a group or on your own, please review the included document and answer the below questions (you can use the other side of this paper or submit this electronically).

1. What are one or two areas in the *Climate Change in Maryland: A Resource For Educators* document that you think would be useful for your education program or classroom? Describe why would this/these would useful.

2. Describe one or two activities, lessons, or curricular units that you already implement or might develop that would build on the content in the *Climate Change in Maryland: A Resource For Educators* document. Please be as specific as possible.

3. Describe what you need to effectively develop and implement these activities, lessons or curricular units in your education program or classroom. These might include additional information or resources, online or face-to-face professional development, connections with scientists or resource managers, climate or other scientific data, graphics and maps (static or interactive), supplies, or classroom assistance. Please be as specific as possible.

4. Provide name(s), organization(s), and email address(es) for you or everyone in your group.