

Pennsylvania Biological Survey Technical Committee Climate Change Survey

How do you think climate change will impact your taxa? Would you rate it as a high, medium, or low priority?

Fishes Technical Committee

I would say most have not, but as you are aware, we at CalU have begun to look at it and welcome the chance to seek additional funding to provide baseline data for cold/cool water fishes. Bill Kimmel and I are working on a manuscript based off the report we submitted to you concerning our initial findings along the Laurel Hill....hope to get it to reviewers by December.

Mammals Technical Committee

The MTC recently began discussing the likely impact of climate change on Pennsylvania's mammals. Climate change has been a relatively low priority for the committee, but this may be because several other threats (WNS, wind turbines, habitat fragmentation, etc.) are such immediate and great concerns. The consensus of the committee seemed to be that climate change will have a relatively minor impact on most Pennsylvania mammal species, but that certain species will likely face greater impacts. Among the species considered most vulnerable to the effects of climate change are the American water shrew, long-tailed shrew, Indiana bat, small-footed bat, silver-haired bat, Appalachian cottontail, snowshoe hare, northern flying squirrel, Allegheny woodrat, muskrat, fisher, and rock vole.

Vascular Plants Technical Committee

The Vascular Plant Technical Committee has not formally ranked anthropogenic threats to the Pennsylvania flora in any formal or generalized capacity. In practice, recommendations regarding the status of endangered or otherwise threatened species are made on a species-by-species basis, yet the most frequently voiced immediate or near-term threats to such species have been the spread of invasive species, habitat destruction and fragmentation through land development, high deer populations, and natural gas drilling. Climate change caused by Global Warming also has been taken into consideration in particular cases, although it has remained of relatively low priority in practice.

Terrestrial & Aquatic Arthropods Technical Committees

Impacts are expected to vary greatly by species. Species that may decline in the state include northern species with their southern limit in the state, those with limited ability to move to new habitats, habitat and foodplant specialists, species of cold water streams (e.g., stoneflies), etc. It is an important issue but hard to address given that the basic life history requirements for most invertebrates are not known.

Bryophytes & Lichens Technical Committee

Almost certainly many bryophyte and lichen taxa could be negatively impacted, especially if drying of the microhabitat is involved. Many species are at their range edges, or disjunct, and changes in climate could cause changes at the microhabitat level that would result in the severe decline or extirpation of species from PA. In addition to changes in microhabitats, there are questions regarding host substrates. If the hosts change (distribution, extirpation, etc) we can't predict how the lichens will respond.

Ornithology Technical Committee

The OTC considers climate change to be a high priority issue facing birds currently and in the future. Changes in bird phenology including timing of migration and breeding have been well documented along with shifts in wintering range. Climate change is expected to affect habitat quality, availability and associated resources; resulting in continued shifts in range and phenology, changes in community interactions, and species declines. Species that may be particularly vulnerable include species with southern range limits in Pennsylvania, and wetland species and species associated with riparian areas due to greater extremes in precipitation events resulting in both drought and flooding, erosion along streams, and unpredictable water levels exacerbating other threats. High elevation/cooler microclimate species (Brown Creeper, Northern Waterthrush, White-throated Sparrow, perhaps Northern Goshawk) could also be among the first to respond to climate change.

Has your committee begun to look at climate change impacts? Does your committee have literature/references documenting effects (or non-effects) of changing climate, especially as it pertains to PA species?

Fishes Technical Committee

The literature is replete with fisheries examples (some are below as pdf others...just the citation provided), but few if any specifically from PA. Below is a pdf link to the PFBC's amendment to the Wildlife Action Plan which speaks to GCC. I have also included a few other seminal papers on the subject that have guided decision making and policy for coldwater fishes. One of my past advisors at Virginia Tech, Andy Dolloff is leading a study now along the Appalachian Mountains investigating this issue. I believe the US Forest Service has some dedicated funding for this work. Also, contacts I have in Maine and New Hampshire are banding together with folks in NY and MA to address the issue on a regional basis. Problem for these folks is a lack of state funding. I believe the Eaton and Scheller reference below predicted that PA would be pretty hard hit with increases in GCC. I can get copies of these papers should you require them.

http://fishandboat.com/promo/grants/swg/nongame_plan/pa_wap_amend_2.pdf

<http://changingclimate.osu.edu/assets/pubs/ficke-2007.pdf>

<http://www.webpages.uidaho.edu/envs501/downloads/Heino%20et%20al.%202009.pdf>

<http://www.geobabble.org/~hnw/trout.pdf>

http://www.ocvts.org/classroomconnect/classrooms/jwnek/documents/Oceanography/Global_Change_Chesapeake.pdf

<http://ottokinne.de/articles/cr/14/c014p207.pdf>

Eaton, J.G. and R.M. Scheller. 1996. Effects of climate warming on fish thermal habitat in streams of the United States. *Limnology and Oceanography* 41:1109-1115.

Flebbe, et al. 2006. Spatial modeling to project southern Appalachian trout distribution in a warmer climate. *Transactions of the American Fisheries Society* 135:1371-1382.

Meisner, J.D. 1990. Effect of climatic warming on the southern margins of the native range of brook trout, *Salvelinus fontinalis*. *Canadian Journal of Fisheries and Aquatic Sciences* 47:1065-1070.

Meisner, J.D. 1990. Potential loss of thermal habitat for brook trout, due to climatic warming, in two southern Ontario streams. *Transactions of the American Fisheries Society* 119:282-291.

Mammals Technical Committee

The MTC as a committee is just beginning to investigate the impacts of climate change on Pennsylvania's mammals. However, the committee does have access to scientific literature relating to the impact of climate change on mammals in Pennsylvania and other states.

Vascular Plants Technical Committee

The VPTC has not looked at climate change impacts on a systematic, committee-wide basis. However, members of the committee do have access to the relevant scientific literature and climate change has been a consideration forwarded by various members when discussing particular proposals regarding Plants of Special Concern (e.g. using an assumption that warming may allow for southern species to expand northwards into the Commonwealth, and that climate warming and related consequences may pressure or even harm populations of species restricted to northern or high-elevational habitats in the Commonwealth).

Terrestrial & Aquatic Arthropods Technical Committees

We haven't addressed it as a committee, but individual members through their agencies/institutions have begun to look at impacts and accumulate literature. Most literature is not Pennsylvania specific but can still be useful when considering potential impacts on invertebrates in Pennsylvania.

Bryophytes & Lichens Technical Committee

Basically no. However an entire text on bryophyte ecology and climate change is available. At this time lots of speculation.

Ornithology Technical Committee

We have not looked specifically at climate change effects but many of the long term avian monitoring projects conducted across PA may be useful in detecting broad patterns of change due to climate change. These include the Breeding Bird Survey, Christmas Bird Count, raptor

migration counts, raptor banding, IBA monitoring and banding stations. The 2nd Breeding Bird Atlas can be used to both look at individual changes in distribution of breeding birds over the past 20 years and serve as a baseline for changes that may occur in future years. Ongoing BBS data and Christmas Bird Count data have already documented shifts in some species. These will continue to be important sources of information in the future. Banding data from Powdermill Nature Reserve has been used to document a number of changes associated with climate change.

Relevant Publications:

Matthews, S.N., L. R. Iverson, A.M. Prasad, A. M., and M.P. Peters. 2007-ongoing. A Climate Change Atlas for 147 Bird Species of the Eastern United States [database]. <http://www.nrs.fs.fed.us/atlas/bird>, Northern Research Station, USDA Forest Service, Delaware, Ohio. (Not specific to PA but includes birds in PA)

Van Buskirk, J., R. S. Mulvihill, and R. C. Leberman. 2009. Variable shifts in spring and autumn migration phenology in North American songbirds associated with climate change. *Global Change Biology* 15:760-771.

Van Buskirk, J., R. S. Mulvihill, and R. C. Leberman. 2010. Declining body sizes in North American birds associated with climate change. *Oikos* 119:1047-1055.

Van Buskirk, J., R. S. Mulvihill, and R. C. Leberman. 2012. Phenotypic plasticity alone cannot explain climate-induced change in avian migration timing. *Ecology and Evolution* 2:2430-2437.

Are any of your members addressing climate change in their individual research? If so, please provide a brief synopsis.

Fishes Technical Committee

Yes, we (Dave Argent) want to continue our studies on the possible effects of GCC on coldwater fishes...just need funding to keep it going. There are three keys we believe to resilience in the face of GCC: (1) protection of groundwater supply as this will feed coldwater streams with a constant source of coldwater; (2) maintenance of water quality as many aquatic species are sensitive to pollution/contamination; and (3) maintenance of the riparian zone to insulate streams and facilitate resistance to ambient air temperature changes.

Mammals Technical Committee

Several members of the MTC are involved in research that relates to the impacts of climate change:

- Carolyn Mahan, Mike Steele, and Greg Turner were co-authors on a recent paper that attributed climate change as the cause of recent hybridization between northern flying squirrels (*Glaucomys sabrinus*) and southern flying squirrels (*G. volans*).
- Tom Hardisky has worked with other furbearer biologists in the northeastern US to assess possible impacts of climate change on mammals commonly trapped for their fur.

- Duane Diefenbach will be investigating the possible impact of climate change on the snowshoe hare's persistence and distribution.
- Bat biologists on the MTC have many decades of data on bat activity that may be able to address phenological changes in bat activity, including entrance and emergence dates for hibernation.

Vascular Plants Technical Committee

At least one member of the VPTC is addressing climate change in his individual research. Dr. Christopher Hardy (Millersville University) and two of his students have been modeling the effects of near-future climate change (i.e., that expected by the year 2050) on the invasive potential of exotic plants. This involves the construction of climatic niche models using herbarium specimen data combined with field observations to calibrate predictions. Below are two conference abstracts describing this work:

Abstract from *Botany 2012* (2012 Botanical Society of America Conference, Columbus, Ohio)

Impact of climate change on potentially invasive exotic trees of Pennsylvania.

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James C. Parks Herbarium, Biology, Millersville University,
PO Box 1002 , Millersville, PA, 17551, USA

One goal for the Pennsylvania Department of Conservation and Natural Resources (DCNR) and similar agencies is to help protect Pennsylvania's natural resources by identifying and controlling the spread of invasive exotic plants that can harm native ecosystems. The DCNR Watch List, for example, is a list of exotic plants that are now showing invasive tendencies within or near state boundaries, and this list represents an attempt to be more proactive in the fight against the spread of invasive exotics. This list, however, includes only species already showing invasive potential and it does not explicitly take into account the impact of near-future climate change scenarios on the spread or contraction of these species' ranges. Additionally, the Watch List strategy does not attempt to identify currently "well behaved" exotic ornamentals that could become problematic when the near-future climate becomes more favorable to their spread. In order to aid park managers and agencies like the DCNR in controlling the future spread of potential exotic invasives, we used herbarium specimen data with current and future (year 2050) climate models to map and rank the potential spread of commonly cultivated exotic trees in Pennsylvania. We found that *Zelkova serrata* (Japanese zelkova) ranked among the highest increases (46%) in its invasive potential, whereas *Acer griseum* (paperbark maple) is projected to exhibit the lowest increase (actually, a decrease of 6.6%) in its invasive potential in the state. These results demonstrate how specimen data and widely accepted climate change scenarios can be used to predict the threat and quantify the future spread of cultivated exotic species, and that such models can be used as a tool to prioritize control efforts or educational campaigns in order to protect native ecosystems from invasion.

Abstract from *Botany 2008* (2008 Botanical Society of America Conference, Vancouver, British Columbia)

Biogeography and predictive niche-modeling of invasive or non-native North American species of dayflower (*Commelina*, Commelinaceae).

John Brakeall, Lindsey Sloat, and Christopher R. Hardy
James C. Parks Herbarium, Biology, Millersville University,
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There are nine species of *Commelina* in the Flora of North America, three of which are native, and six of which are non-native. Of the non-native species, two or three are considered invasive. The objective of this study was to identify the geographic origins, estimate climatic envelopes, and determine rates of biogeographic spread of invasive *Commelina* species within North America. We used innovative georeferencing software and GIS programs to model species ranges and make predictions about states and counties open to invasion. The result of this study may facilitate efforts to mitigate the spread of invasive species, which generally are regarded as one of the main reasons for loss in biodiversity and crop yields. Invasive species impact nearly half of the species listed as Threatened or Endangered under the Endangered Species Act. According to the USDA, the U.S. spends 120 billion annually on the control and impact of invasive species.

Terrestrial & Aquatic Arthropods Technical Committees

Several members and also individuals outside of the TCs are doing research that directly or indirectly addresses invertebrates and climate change.

- As part of a Wild Resource Conservation Program grant awarded to the Western Pennsylvania Conservancy, seventeen invertebrate species were evaluated in terms of their vulnerability to climate change. The following species and their vulnerability rank follow:
 - An Isopod (*Caecidotea kenki*) – Presumed Stable
 - Frosted Elfin (*Callophrys irus*) – Presumed Stable
 - Northern Metalmark (*Calephelis borealis*) – Moderately Vulnerable
 - Red-banded Hairstreak (*Calycopis cecrops*) – Increase Likely
 - Appalachian Tiger Beetle (*Cicindela ancocisconensis*) – Moderately Vulnerable
 - Cobblestone Tiger Beetle (*Cicindela marginipennis*) - Moderately Vulnerable
 - Northern Barrens Tiger Beetle (*Cicindela patruela*) – Presumed Stable
 - Rapids Clubtail (*Gomphus quadricolor*) – Moderately Vulnerable
 - Green-faced Clubtail (*Gomphus viridifrons*) – Moderately Vulnerable
 - Fingered Lemmeria Moth (*Lemmeria digitalis*) – Presumed Stable
 - Bog Copper (*Lycaena epixanthe*) – Highly Vulnerable
 - Flypoison Borer Moth (*Papaipema* sp. 1) – Moderately Vulnerable

- West Virginia White (*Pieris virginiensis*) – Highly Vulnerable
 - Appalachian Grizzled Skipper (*Pyrgus wyandot*) – Moderately Vulnerable
 - Regal Fritillary (*Speyeria idalia*) – Presumed Stable
 - Refton Cave Planarian (*Sphalloplana pricei*) – Presumed Stable
 - Stellmack's Cave Amphipod (*Stygobromus stellmacki*) – Presumed Stable
 - Northeastern Pine Zale (*Zale curema*) – Presumed Stable
- Long term species data from a site can document changes in species distribution that may result from a changing climate. Dr. Hal White of the University of Delaware is working with Clark Shiffer of State College, retired wildlife biologist with the Pennsylvania Fish and Boat Commission, to publish on 50 years of dragonfly and damselfly data from the Ten Acre Pond in Centre County.
 - Dr. Diane Husic, Professor of Biological Sciences at Moravian College, is not a AA or TA member, but she has been gathering phenological data for species in eastern Pennsylvania. She has a lot of information on birds, but she is interested in expanding her datasets on insect and plant phenology. Birds need to find the right insects to feed their young, but will their spring migration stay in sync with insect emergences? Will pollinators stay synchronized with the flowering of their preferred plants? Dr. Husic is also interested in looking at stream data such as temperatures, levels, flood events, etc. and how these impact the ecosystem. Several websites to visit for more information:
 - Eastern Pennsylvania Phenology: <http://watchingtheseasons.blogspot.com/>
 - Lehigh Gap Nature Center: Eastern PA Phenology Project: <http://lgnc.org/research/phenology>
 - To submit data: phenology@lgnc.org

Bryophytes & Lichens Technical Committee

Collecting baseline data so that we can determine what is happening in the future.

Ornithology Technical Committee

- Northern Goshawk Survey – A graduate student at PSU in cooperation with PGC is initiating a statewide survey of goshawks and an analysis of distribution and abundance shifts over the past 25 years.
- Northern Waterthrush – Terry Master and graduate student - reproductive, foraging and habitat metrics between low and high elevation sites. Study is currently in design phase but will attempt to address climate change effects.
- Winter raptor distribution – Laurie Goodrich and Hawk Mountain biologists – Examined if range had changed over time and found slight indication of more northerly wintering in kestrels. Other research has been done on redtails and roughlegs showing more northerly wintering ranges.

- Climate Change Vulnerability Index – Pennsylvania Natural Heritage Program - <http://www.naturalheritage.state.pa.us/CCVI.aspx> - Index predicts population changes due to climate change.
- Water bird vulnerability to climate change – Sarah Sargent- Ongoing project using the Naturserve CCVI to assess waterbird vulnerability.