Water Resources, Bear Creek Preserve

Brief Climate Change Vulnerability Assessment for the Natural Lands Climate Adaptation Project

This document represents a brief evaluation of climate change vulnerability for water resources in the Natural Lands' Bear Creek Preserve in Luzerne County, Pennsylvania. The following information was based on expert input provided in fall 2022 as well as sources from the scientific literature.

Habitat Description

Bear Creek Preserve, located in Luzerne County, Pennsylvania, is within the Lehigh Watershed and contains Shades Creek, Bear Creek, and Stony Run streams as well as numerous headwater seeps and springs that merge with the 6.5 miles of these streams that run through the preserve (*1*). Bear Creek and the Lehigh River merge at the impoundments created by the Francis E. Walter Dam located downstream of the preserve (*2*). All streams within the preserve are classified as "High-Quality Cold Water Fisheries" by the Pennsylvania Department of Environmental Protection, and are habitats for native fish species (e.g., brook trout [*Salvelinus fontinalis*]). Small permanent and seasonal wetlands are scattered throughout the preserve as well (*2*). The wetland and stream habitats include a mix of wetland grasses and sedges (Canada rush [*Juncus canadensis]*, wool-grass [*Scirpus cyperinus*], jewelweed [*Impatiens capensis*], marsh St. John's wort [Hypericum virginicum]), woody shrubs (highbush blueberry [*Vaccinium corymbosum*]), conifers including red spruce [*Picea ruben*] and hemlock [*Tsuga canadensis*], and red maple [*Acer rubrum*] communities (*1*).

The water resources within the preserve provide food, shelter, breeding habitat, and migratory corridors for a variety of mammals (northern river otter [*Lontra canadensis*], beaver [*Castor canadensis]*), birds (wood duck [*Aix sponsa*], mallard [*Anas platyrhynchos*], Canada goose [*Branta canadensis*]), invertebrates (stonefly nymph [*Plecoptera]*, caddie fly nymph [*Trichoptera*], water striders [*Gerridae*]), amphibians (Green frog [*Rana clamitans*], spotted salamander [*Ambystoma maculatum*]), and reptiles (wood turtle [*Glyptemys insculpta*], northern water snake [*Nerodia sipedon*]) (*1*).

Key Climate Vulnerabilities

High Vulnerability

High Confidence

Vulnerability is evaluated by considering the habitat's sensitivity and exposure to various climate and non-climate stressors as well as the habitat's adaptive capacity or ability to cope with these stressors with minimal disruption. The overall vulnerability of the habitat is ranked on a scale from low vulnerability (dark green) to high vulnerability (yellow). The confidence in the vulnerability ranking's accuracy is similarly ranked on a scale from low (light blue) to high (dark blue).

Sensitivity & Exposure

***Sensitivity** is a measure of whether and how a habitat is likely to be affected by a given change in climate and climate-driven factors, changes in disturbance regimes, and non-climate stressors. By contrast, **exposure** is a* *measure of how much change in these factors a resource is likely to experience. Sensitivity and exposure are combined here for a score representing climate change impact, with high (yellow) impact scores corresponding to increased vulnerability and low (dark green) scores suggesting a habitat is less vulnerable to climate change.*

Potential impacts of projected climate changes on the habitat include:

- Aquatic species may experience changes in growth, reproduction, survival, and geographic distribution as a result of increased water temperatures (*3*, *4*). Brook trout growth rates, in particular, are sensitive to warmer water temperatures (*5*–*7*), which can lead to rapid growth and influence the timing of individual trout maturation and reproduction success. Warmer water temperatures can also decrease the dissolved oxygen (DO) concentrations in a stream, impacting the respiration capability of in-stream vegetation (*8*, *9*) and increasing stress, disease, and mortality in fish and aquatic invertebrates.
- Changes in species composition and the survival of aquatic plants, invertebrates, and fish due to alterations in seasonal streamflow (*3*, *10*). Some invertebrate species are particularly sensitive to changes in streamflow velocity and water quality (e.g., caddisfly and stonefly nymphs). Macroinvertebrates are food sources for other stream species, such as trout, and depleting these species could impact ecosystem structure, nutrient cycling, plant decomposition, and stream species composition (*11*).
- Changes in the amount of runoff and groundwater movement throughout the preserve due to increased rainfall during the winter and spring months, with flow increases likely transporting nutrients and sediments that could impact the water quality of the preserve's wetlands and streams (*3*).
- Reduced establishment and growth of new seedlings where warmer temperatures and changes in precipitation lead to an unsuitable dry environment, affecting which plant species are able to grow to maturity in the habitat (*4*, *12*). For example, warmer temperatures will likely lead to warmer and drier soils in wetland communities, which can cause mortality events of tree and plant species not well adapted to dry conditions (*13*, *14*). As temperatures rise, plant hardiness zones in the region will also shift (*15*), which is likely to be associated with changes in plant species composition within the preserve, forcing some wildlife out of their normal home range, changing the ecosystem structure, and possibly increasing the risk of invasion (*16*–*19*).
- Damage to forest vegetation and soils as a result of extreme flooding and storm events, which intercept and filter precipitation, helping to maintain these high-quality water resources while helping to slow local stormwater runoff and reducing flooding. Damage may be particularly severe for non-flood-tolerant species and young plants in a period of early growth, impacting seedling establishment, growth, and survival of woody plant species that help to prevent erosion in and around water resources (*20*). However, more prolonged flooding may not have negative impacts in streams and wetland areas that are already accustomed to periods of inundation or seasonal flooding.

The water resources of Bear Creek may also be vulnerable to non-climate stressors that segment or divert waterways (e.g., Francis E. Walter Dam and nearby roads) as well as trash and pollution from nearby agricultural, residential, and industrial areas that decrease water quality (*21*). Currently, significant runoff is received from Route 115, which crosses Shades Creek on the eastern border of the preserve (*21*). Flooding events and increased precipitation may contribute to the reduction in water quality by spreading runoff and pollutants as well as the destruction of trails within the preserve, making them inaccessible and bringing debris and other hazards into the streams and wetlands (*21*).

Adaptive Capacity

***Adaptive capacity** is the ability of a habitat to accommodate or cope with climate change impacts with minimal disruption. High adaptive capacity (dark green) corresponds to lower overall climate change vulnerability, while low adaptive capacity (yellow) means that the habitat will be less likely to cope with the adverse effects of climate change, thus increasing the vulnerability of the habitat.*

Intrinsic (i.e., inherent characteristics) and extrinsic (i.e., management potential) factors that enhance or undermine the ability of water resources to cope with climate impacts include:

Intrinsic Factors

- ▲ Good water quality within Bear Creek Preserve currently, which contributes to the health of downstream ecosystems (*21*)
- ▲ Low deer grazing impacts and invasive species within the preserve provide new seedlings the opportunity to become established and replace damaged mature trees (*21*)
- ▼ Discontinuous waterways within the preserve, including portions disrupted by the high dam on Bear Creek, could prevent the migration of aquatic organisms to the already limited refugia near the preserve and be detrimental for species that may need to undergo range shifts in response to the effects of climate change (*3*, *21*)

Extrinsic Factors

- ▲ Strong public support for stream and wetland protection to conserve the aesthetic beauty within the preserve (*21*)
- ▲ Increased likelihood of management support due to the value of water resources for both the public water supply and downstream ecosystems (*21*)
- ▲ Existing efforts are underway to protect streams from invasive species and remove trash and pollutants in order to maintain water quality
- ▼ Uncertain future financial support for water resource management for the impacts of climate change (*21*)
- ▼ Continued challenge of not having control over the influx of contaminants from agricultural, industrial, and residential areas that exist outside of the preserve (*21*)

Recommended Citation

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Further information on the Natural Lands Climate Adaptation Project is available on the project page (https://ecoadapt.org/goto/Natural-Lands).

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