

**Promoting Coastal Resilience in Northern Delaware
by Restoring Ecosystem Services Furnished by Freshwater Mussel Beds**

Location: A tributary to Middle Run, White Clay Creek (primary restoration site; a non-tidal stream) and tidal creek within Christina River marsh (secondary site for scientific comparison; a tidal shoreline). White Clay Creek is designated as a National Wild and Scenic River, and is one of the relatively intact corridors remaining in a highly developed area. Part of the watershed is divided into state and county parks. Annually over 175,000 people visit these parks with an economic impact of over \$2.1 million.

Requested funding: Total Request: \$294,000; Match: \$200,000; Total Budget: \$441,000

Description of Issue: The resilience and ecological integrity of most coastal streams in northern Delaware are increasingly degraded by the combined effects of changing climate; historical channel and floodplain manipulation; and expanding development. Increased flooding from storm water impairs diverse ecological processes, promotes erosion, and represents a mounting hazard for coastal communities. These effects can be amplified in lower areas of watersheds where river runoff mixes with increasing sea levels and potential for greater storm surge. With historic deforestation of the region combined with poor land use decisions (including widespread use of milldams), there has been massive erosion of upland sediment that created extensive deposits of sediments within the receiving floodplains. Collectively, this has caused channel incision that disconnected the modern floodplain from the active channel where grade controls within the modern sediment infill are absent.

Fortunately, new and innovative nature-based tactics are being developed to sustain and enhance ecosystem services that promote coastal resilience, and benefit water quality and fish and wildlife. One example being implemented on the Middle Run Tributary is an integrated stream and wetland restoration. This project will reconnect the floodplain to improve stream flow levels and provide water storage capacity during extreme weather events, reestablish the channel bed elevation to allow fish and mussel passage through a roadway culvert, and help to control storm water in non-tidal streams and rivers. Nature-based tactics typically enhance resilience by conserving, restoring or enhancing structural and functional properties rendered by ecologically dominant plants and animals combined with stabilizing habitat manipulations that use abiotic, natural materials.

The project will promote coastal resilience by enhancing beds of native species of freshwater mussels as part of the stream and wetland restoration. Similar to oyster reefs in saltwater, healthy beds of freshwater mussels can reach densities of 10,000-100,000 animals per acre that filter millions of gallons of water and remove tons of suspended sediments per acre per year. Most streams, rivers and tidal fresh tributaries in Delaware are devoid of once abundant mussel beds, representing a historic loss of ecosystem services that would otherwise have helped to sustain coastal resilience.

Actions: Propagate >10,000 juvenile mussels (1 or 2 native species), rear them to a size suitable for use in restoration, and then reintroduce them into a degraded stream as part of an integrated stream and wetland restoration project that will be implemented by DelDOT in 2019-2020 along 1,220 feet of Middle Run Tributary, White Clay Creek. The habitat suitability for mussels will be enhanced in areas of the restoration site by modifying the design to reduce bed transport rates and frictional velocities, using rock and timber. Since mussel bed restoration is a new concept, monitoring by both scientists and citizen scientists will track the growth and survival of reintroduced mussel beds, and their associated ecosystem services. To strengthen lessons learned and pave the way for expanded mussel bed restoration along the river continuum, a similar number of mussels will be used to test mussel bed restoration along an eroding tidal shoreline of the Christina River (downstream of White Clay Creek), and resulting outcomes will be

studied as paired comparisons between the non-tidal and tidal restoration sites. Outcomes will be conveyed via outreach to resources managers and the public.

Expected Impact: This project will restore instream habitats to boost carrying capacity for native freshwater mussels, thereby augmenting water quality in an impaired watershed, help to stabilize erosion, and increase habitat complexity and value for other fish and wildlife. The project will have national implications because it represents an innovative demonstration of a new nature-based tactic for addressing coastal resilience.

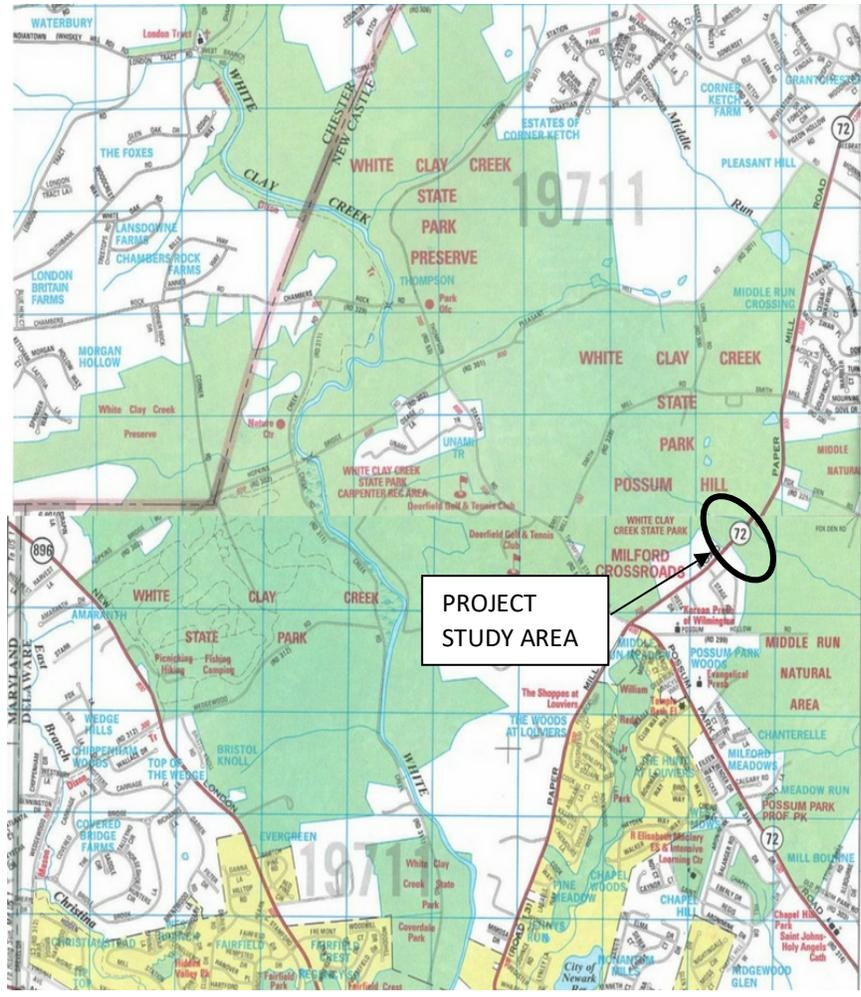
Performance Measures: The ultimate success of this project will be measured as a reduction in on-site erosion, bed load transport, and waterborne particulate pollutant load at the mussel restoration sites, compared to baseline conditions. Additional performance metrics include number of mussels propagated, mussel growth rate, survival, and final population biomass *in situ*.

Habitat and Species Benefits: Freshwater mussels are the most imperiled of all animals in the United States. Even “common” species of mussels are declining in abundance and range, especially in northern Delaware. Most rare mussel species benefit from robust beds of common mussels because they modify the habitat to make it more suitable for all species. Therefore, this project will directly promote the recovery of state-listed mussel species by improving the habitat conditions that sustain them. Fish and wildlife also derive many direct and indirect benefits from healthy populations of bivalve shellfish. For example, early life stages of many fish species prosper in or near shellfish beds, which can represent essential fish habitat. Many mammals, birds, and fish prey on mussels and other bivalves. Beds of mussels boost habitat complexity and enrich sediments, thus enhancing macroinvertebrates that are eaten by fish and wildlife. In turn, fish are essential for freshwater mussels because they are necessary for (natural) mussel reproduction. Sustainable fisheries and prospects for listed species of fish and wildlife are therefore enhanced by restoration of native species of bivalves, including freshwater mussels.

Collaborating Partners: This project is a public-private partnership that includes state and federal agencies, non-profit and private sector organizations. Delaware Department of Transportation (DelDOT) is leading the integrated stream and wetland restoration on Middle Run Tributary (project is currently in final engineering stages), funded separately and provided as match, and helping coordinate partners. Partnership for the Delaware Estuary, Inc. (PDE) will serve as the project coordinator and technical lead for the mussel restoration and monitoring as part of a multi-state Freshwater Mussel Recovery Program that it has coordinated since 2007 (see <http://www.delawareestuary.org/science-and-research/freshwater-mussels/freshwater-mussels-scientific-studies/>). Other key collaborators include the US Fish & Wildlife Service, which will propagate mussel seed using methods developed previously with PDE. Mussel seed will be conditioned in ponds owned by Winterthur Gardens, a non-profit. The firm that designed the integrated stream and wetland restoration, RK&K, will assist PDE with design and construction of mussel habitat structures. Finally, the White Clay Creek Wild and Scenic River Program will monitor water quality pre and post construction (funded separately and used as match), assist PDE with outreach and engage citizen scientists to tend mussel gardens and monitor outcomes.

Timeline: October 2018 – September 2021 (36 months)

Permits and Approvals: Existing restoration project permits will be modified, if warranted, to include habitat construction to address mussel bed needs. An existing scientific collector permit (to PDE from DNREC) already covers mussel propagation and reintroduction studies, and this will be modified to specify the new site(s). All restoration projects will be completed on public property owned and managed by the state or county.



PROJECT STUDY AREA