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Investing in Strategies to Accelerate Conservation and Measure Impact in the Delaware River Watershed

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Abstract

The Delaware River watershed provides drinking water to over 15 million people, critical habitat for plants and animals, including many threatened and endangered species, and recreational and economic enterprise valued at $10 billion per year in direct wages. Water quality and associated economic, environmental and social values have improved dramatically since the 1950s when the lower portion of the river was declared a dead zone during parts of the summer due to excessive inputs of domestic and industrial waste. The question today is how to ensure that progress continues in the face of persistent and growing threats to water quality. Recognizing the challenges facing the watershed, over 40 of the leading conservation groups in this 13,000 square mile region are pursuing a 10-year strategic initiative focused on water quality through the Delaware River Watershed Initiative, a conservation program advancing a combination of place-based work in watershed protection, restoration, education, collaboration and innovation through collective impact. This paper serves as an invitation for broader strategic involvement to accelerate watershed protection and restoration; it also is a springboard for stakeholders to set an agenda for ensuring that the Delaware River watershed delivers clean water for humans, plants and animals. The paper identifies eight "clusters" of sub-watersheds, constituting approximately 25 percent of the total Delaware Basin, where analysis has shown that investment in water quality could deliver significant returns. Diverse geology, land use, development patterns, population density and environmental stressors are present throughout these sub-watershed clusters. Focusing conservation actions in these places contributes directly to local water quality, and by fostering experimentation and innovation, it also cultivates a wide range of effective approaches for scaling up investment across the Delaware River watershed and beyond. This paper emphasizes five strategies for investing in protection of high quality waters and restoration of impaired waters: 1. protect forested headwaters to maintain high water quality; 2. manage agricultural lands to reduce polluted runoff and increase groundwater infiltration; 3. implement best practices and new financial incentives to reduce urban stormwater pollution through natural processes; 4. increase the evidence base for watershed protection by monitoring trends in water quality and assessing project impacts; 5. improve policy and practice through applied research focused on water quality outcomes. These strategies demand place-based work, and the Delawre River Watershed Initiative will focus on advancing these efforts through the cooperation of organizations located in the eight distinct watershed clusters. Proceeding downstream from the headwaters, the eight landscapes

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are: Pocono Mountains and Kittatinny Ridge; New Jersey Highlands; Upper Lehigh River; Middle Schuylkill River; Schuylkill Highlands; Brandywine and Christina Rivers Upstream; Suburban Philadelphia; and Kirkwood-Cohansey Aquifer (comprising New Jersey's Bayshore; and Pine Barrens). These clusters bring together many of the most ecologically valuable and significantly impaired areas of the watershed. They are strategically located where strong organizations and critical natural vatues provide measurable opportunities for advancing local water quality while having regional impact. The selection of areas and strategies was based on research and planning undertaken by the Open Space Institute (OSI) and the Academy of Natural Sciences of Drexel University (ANSDU} with support from the William Penn Foundation. Researchers at OSI and ANSDU were joined by the National Fish and Wildlfe Foundation (NFWF) in engaging over 40 organizations working across the eight sub-watershed clusters to develop collaborative plans for implementing and measuring local conservation strategies essential to the long-term health and vibrancy of the region. These implementation plans tackle major threats to water quality and include strategies to track progress and share lessons learned. The plans provide a framework for public agencies and philanthropic funders seeking to pursue targeted watershed protection outcomes supported by monitoring, technical assistance and ongoing communications. Organizations large and small, public and private, are invited to read this paper and consider this program as an opportunity to align investment for greater impact and help ensure a bright future for the Delaware River watershed.

Keywords

Environment, Watershed, Ecology, Stewardship, Land Management, Water Quality, Adaptive Management, Delaware River, Mid-Atlantic, Innovation, Collaboration, Community

1. Introduction

The Delaware is an iconic river of the United States and a historically and ecologically important tourist destination [1]. However, the Delaware River and its many tributaries remain underappreciated and insufficiently protected considering their importance as a source of drinking water, habitat for commercially and ecologically significant wildlife and numerous other public benefits. Water quality has received attention by policymakers and scientists, and public awareness about the watershed as part of our cultural identity is increasing, but there is a need for continuing work toward maintaining quality, measuring the success of investments and increasing public stewardship of the watershed. As urban development, suburban industrialized agriculture, energy infrastructure and other development continue to adversely affect environment from New York to Delaware, the region's need for a comprehensive approach to protecting and restoring its most precious resource—water—has become increasingly self-evident Fishermen cannot eat the fish they catch; swimmers cannot swim in rivers and streams; boaters must avoid certain areas; children are told to stay out of the water at beaches; some rivers cannot sustain marine life; drinking water intakes are just downstream of dangerously polluted waters; the list goes on [2]. Clean water is the lifeblood of industry, economic opportunity and health. While it is possible for us to have healthy waterways in the Delaware River watershed, we must find new ways to drive successful stewardship of this region which provides drinking water to over 15 million people and supports $25 billion in annual economic activity from recreation, water quality, water supply and other sources [3].

By the mid-1880s, fouled water, factory waste, coal byproducts and agriculture and urban runoff were draining into the waters of the Delaware Basin at an alarming rate [4]. In the first half of the 20th century, the lower Delaware River was infamous for its 20-mile summer dead zone, a stretch of river so polluted at times almost nothing could survive in it [5]. This spurred early efforts to clean up the Delaware, starting with the 1936 formation of the Interstate Commission on the Delaware Basin (INCODEL), a succession of state and federal legislation to reduce point source pollution, eventually leading to the U.S. Environmental Protection Agency's development of the Clean Water Act in 1972 and amendments in 1977 and 1987. We saw clear progress from these command-and-control regulatory initiatives as the establishment of water quality standards and permit systems for pollution discharges led to raised levels of dissolved oxygen and the return of significant populations of

American shad and other aquatic life [6].

The regulatory structures currently in place are essential to the region's water quality, but their effectiveness can depend on inspection and enforcement by public agencies stretched thin by overwhelming responsibilities and a tough fiscal climate [7]. Regulators are challenged to address sources of pollution that are widely distributed across the landscape and cannot be traced back to a single end-of-pipe discharge point or point source. There are over 1000 permitted and controlled point sources of pollution spread across the Delaware River watershed, but there are hundreds of thousands of distributed, or non-point, pollution sources [8]. Non-point source pollution is the watershed's dominant source of critical environmental contaminants like sediment, nutrients and bacteria. It includes major contributions from forest clearing for housing developments and new energy infrastructure; contaminated stormwater washing off oil-stained roads and open construction sites; and agricultural runoff leaving chemically treated crop fields and manure-laden livestock yards [9].

Less than one percent of the watershed's non-point sources are permitted and subject to regulation, but all of them threaten water quality and remain exceedingly difficult to monitor and control [10]. The threat transcends traditional social and political boundaries, challenging communities to forge new relationships in the context of watershed dynamics. In the Delaware River watershed, upstream communities in the forested headwaters rely on urban centers downstream to support a local tourism economy worth just over $3 billion annually and to sustain markets for locally produced quarried stone, farm goods and forest products [11]. In turn, the downstream communities rely upon the forested headwaters of these same upstream communities for a steady supply of clean drinking water also worth just over $3 billion annually [12]. Even within these communities, families living uphill from their local waterways rely on their downhill neighbors along the banks for river access and recreational opportunities such as fishing, boating and riverside trails; while the downhill residents rely on their upstream neighbors to soak up and slow down storm-water that otherwise runs off impervious roofs and driveways, rushing into nearby waterways and contributing to destructive flooding. This equal exchange of goods and services is singularly dependent on continued conservation of natural watershed assets like intact forests and functioning wetlands.

Where stakeholders can embrace a common interest in the landscapes, habitats and livelihoods that depend upon clean water, the natural dynamics of the watershed system can span traditional disciplines and bring new partners together. Given the scale and ubiquity of non-point source pollution, a strategically targeted approach may be necessary to effect measurable change on a meaningful scale. Focused investment within a representative selection of priority landscapes could be used to test new approaches for the restoration of degraded landscapes and the protection of pristine areas. Coupled with integrated monitoring to track and evaluate progress, this work could build a body of evidence for more effective conservation. Align the work of all stakeholders—watershed groups, land trusts, funders, university hydrologists, ecologists, land-use planners, water utilities, regulatory agencies—and each targeted investment could magnify and accelerate positive impacts, making the most of every available dollar.

This requires all stakeholders to think across boundaries and test a range of strategies. Where traditional restoration work focuses downhill along stream banks eroded by high flows, investment in infiltration practices should follow to slow the flow from the suburban yards uphill; where one partner is committed to protecting wildlife and another is focused on adapting to climate change, aligned land protection should capitalize on shared priorities where critical habitat overlaps with flood mitigation areas like floodplains and wetlands. Stakeholders must press for new protections and stringent enforcement of existing regulations while exploring ways to harness the market to create effective, low-cost solutions that complement the government's role in ensuring water quality and then inspire citizens to support the efforts. For these interventions and all others, scientific data should be collected, shared and put to work to inform the public, to inform policy and to inform the professional practice of watershed conservation.

The strategies are complex and the stakes are high. The Delaware River basin provides drinking water to 15 million people through service to New York City and Central New Jersey through the Delaware and Raritan Canal and to residents of the Delaware Basin by way of over 800 community water systems based on both groundwater and surface water [13]. The water resources of the basin are also hydraulically connected to the groundwater resources of the Kirkwood-Cohansey aquifer, which provides drinking water to an additional population of approximately l million people [14] and underlies the 1.1million acre Pine Barrens, a globally significant biosphere reserve designated by the United Nations Educational, Scientific and Cultural Organization (UNESCO) [15]. This combined landscape holds vital drinking water supplies, critical habitat for endangered and threatened plants and animals, and supports economic enterprise and ecosystem services valued at almost half the gross domestic product of the entire state of Delaware.

Collaborative and collective action will be the key to continued progress in achieving water quality goals. Through this document, we propose a new framework for accelerating action on behalf of the Delaware River watershed and invite practitioners, foundations and public officials to participate and help secure measurable positive impacts on water quality and availability for all watershed communities.

2. Threats and Stressors

Upstream-downstream connections demand an integrated approach to protecting the Delaware River watershed. Integrated water resource management was the impetus for the 1936 creation of what was then called the Interstate Commission on the Delaware River (INCODEL), with the premise that watershed management required a regional approach [16]. Evolved from INCODEL, today's Delaware River Basin Commission conducts comprehensive planning that encompasses water quality, supply and conservation [17]. The Commission also helps coordinate and fund regional and local partnerships throughout the watershed. With a long history of promoting cooperation to reach a common goal, the Commission serves as a model for non-governmental organizations as well as federal, state and local governments. These efforts at multi-jurisdiction, basin-scale management are founded on due consideration for the watershed's richly varied geography and wealth of natural resources.

Population growth: The region's human population is currently over 8 million and growing, and conversion of undeveloped land continues to grow with it. Population growth and redistribution across the landscape at lower densities along patterns of urban and suburban sprawl are driving significant impacts to the watershed. The scenic landscapes and lifestyle values of these rural counties have always drawn tourists; today they also attract new residents who have moved from the big metropolitan centers to the east.

Between 1960 and 2010, the U.S. Census Bureau reported that Delaware, New Jersey, New York and Pennsylvania averaged statewide population increases of 20 percent, but most counties in the Delaware Basin experienced an increase of 50 percent or more. A growing population has clear implications for water use and water quality, implications that are associated with development of forested land, increased impervious surfaces and storm-water problems, and all the ramifications of greater demand for the basic necessities of food, water and energy. While population change itself would not be addressed through this initiative directly, with population growth comes an increased responsibility to manage impacts and educate and build constituencies for the conservation of the Delaware River and its many tributaries.

Loss of forest cover: The expansion of developed land to accommodate new residents in recent decades has come at the expense of all other land uses, but especially forested lands and the natural processes of water filtration and purification these lands provide [18]. Agriculture once dominated the lower basin's valleys and plains, and many abandoned farmlands have been converted to forests. These reclaimed lands must be protected from suburban sprawl.

Impervious surface, storm-water, flooding and sewer overflows: Although the ridges and plateau have seen less development and continue to offer spectacular scenery and outdoor experiences, the increase in impervious cover (e.g. concrete, asphalt) that accompanies development elsewhere can intensify flood peaks through reduced soil infiltration [19]. Inadequate sewer systems and increased flooding have led to combined sewer overflows in older cities, which are significant point sources of contaminants during large storm events. Runoff from impervious surfaces is also the source of particulate pollutants, motor oil, chemicals and other contaminants in storm-water and is one of the largest sources of nutrient loading in suburban and urban watersheds [20]. Nutrients, sediment, agricultural toxins and emerging contaminants introduced by storm-water and agricultural runoff have become more apparent as end-of-pipe effluent has decreased [21]. This non-point source pollution is generated in suburban backyards and roadways as well as on the farms that feed this populous region. Storm-water control requires citizen engagement, new strategies involving both regulations and incentives, holistic water resource planning, and working across political and professional boundaries.

Agricultural pollution: Farms in the watershed can contribute to loss of riparian buffers and to pollution through runoff containing bacteria, pesticides, nutrients and sediment. The Delaware River has higher concentrations of effluent and nitrogen than many other major rivers of the Mid-Atlantic and the Northeast. Surprising to most, the concentration or intensity of nutrient loads coming into the Delaware River estuary, measured as load per unit volume of the receiving waterbody, is greater than what flows into the neighboring Chesapeake

Bay [22]. The Delaware Bay is spared the eutrophication and hypoxia that afflict the Chesapeake only because nutrients are more quickly and easily flushed out of the Delaware tidal zone [23].

Declines in aquifer water levels: Water withdrawals for agriculture, drinking water and industry draw down aquifers and increase the concentration of pollutants in watercourses' remaining flow. New Jersey's shallow aquifer, the Kirkwood-Cohansey, feeds the headwaters of many Delaware tributaries along with heavy industrial and residential users, and the current rate of groundwater withdrawals are unsustainable, reducing stream flows and dewatering wetlands [24]. The Delaware River Basin Commission has identified two areas of critical concern in the upper estuary—southeastern Pennsylvania and south-central New Jersey—where additional withdrawals must be limited or prohibited if long-term yields of water are to be sustainable.

Loss of riparian buffers: The area adjacent to a stream, the riparian zone, is essential for maintaining stable stream banks. This zone also acts as a filter to water flowing from the surrounding land, which contains contaminants and nutrients that are carried to the stream in runoff [25]. Forested riparian areas have been found to filter a significant portion of the runoff generated by human activities on surrounding land and provide essential protection for water quality [26]. In the past, land development for urban and agricultural uses included vital streamside habitat.

Climate change: The growing climate crisis is a major intensifying factor of the stressors described above and an important context for all work in the watershed. Projected changes in the Delaware Basin include higher temperatures, especially in winter, and more intense rainfall events with greater dry periods between them [27]. Predictive modeling has shown that climate change affects water quality and quantity in a watershed. Climate change reduces snowfall, decreases the snow-pack volume and increases the rate of evapo-transpiration, thus reducing the year-round water storage volume of a watershed and causing fluctuations in flow, especially during high water demand times. Higher temperatures also increase the percentage of winter precipitation in the form of rain (rather than snow). This, in addition to climate change-related early snowmelt, increases runoff and causes fluctuations in water level and flow that deviate from the natural cycles. This extra runoff also changes the timing and magnitude of sediment loading (by up to 50 percent) and is responsible for disruptions of nutrient cycles and ratios that can lead to increased algae and plant biomass and eutrophication [28].

Energy development: The region is attracting an estimated $2 billion in energy pipelines that will cross the landscape [29]. Should the Delaware River Basin Commission lift its moratorium, extraction of oil and gas from Marcellus Shale and other sources will involve construction of new pipelines, forest clearing, large withdrawals of water, high volumes of chemical brine wastewater, stormwater runoff from drilling sites and roads, and potential spills and accidents that could directly threaten drinking water quality [30]. Some of the chemicals found in natural gas wastewater are not governed by existing water quality regulations, precluding regulators from issuing permits that could safeguard water quality.

3. Place-Based Strategies

Decades of intervention by public and private funders suggest that regional research and policy advocacy cannot succeed without local stakeholders' efforts. It is on the ground that the work gets done—whether it is gaining the trust of local farmers, working with the town planning board or installing rain barrels to capture stormwater runoff. Such place-based strategies can target specific sub-watersheds, test innovative approaches and refine best practices. With well-chosen strategies and careful monitoring, specific places can become laboratories and the solutions can be scaled up. Because water quality improvements are largely incremental and resources are finite, it is imperative to focus investment.

To select locations for the place-based investment, ANSDU researchers studied land cover and water quality data and developed an index for prioritizing restoration of sub-watersheds with degradation from urban and agricultural activities as well as areas optimal for land protection. Next, to identify groups with the capacity to participate in these collaborative restoration and protection projects, OSI reviewed stressors, strategies and institutional capacity. The study involved more than 50 interviews and a review of reports and data from across the 13,000 square miles of the watershed, covering four states and many local jurisdictions. The goal was to identify places at the intersection of science and practice-that is, where investment in water quality would have the highest potential for significant returns and where practitioners had the capacity to effect measurable change, whether through protection of intact waters or restoration of degraded streams.

4. Cross-Cutting Innovation

Investments can pilot potential models and catalyze regional efforts, but their success is often compromised by larger forces. Energy development, climate change, exurban sprawl and acid rain are examples of stressors that cut across ecological and government boundaries and may require a regional response. ln a basin as large and complex as the Delaware Basin, with its combination of point and non-point sources, the array of threats and potential responses can be daunting. A complicating factor is the patchwork of sometimes conflicting, or at least inconsistent, regulations at the intersection of federal, state and regional governance. A case in point is the divergent approaches to hydraulic fracturing ("fracking"), from Pennsylvania's aggressive support to New York's more cautious stance to the Delaware River Basin Commission's struggle to find the balance between political and natural resource considerations. In desk research and interviews with key stakeholders, the authors found significant differences in basin-wide knowledge and policy, identifying gaps and a need to coordinate within the public and nonprofit sectors on how best to fill them.

The key parameters of such a coordinating strategy include:

- Aligning Scientific Background and Research Opportunities
- Developing a Shared, Applied Research Agenda
- Creating New Models of Sustainable Watershed Finance
- Deepening and Broadening Public Support
- Protecting Source Water

5. Invitation to Shape the Future

From June through August 2013, over 40 organizations that are invested in the future of the Delaware River basin participated in the development of eight detailed implementation plans that define strategies for ensuring a promising future for the Delaware River, its tributaries and the people, industry, community and lands that shape both the morphology and quality of those streams.

Together, these eight plans represent one of the greatest investments of time, intellect and private support to develop a collaborative approach to protection and restoration in critical sub-watersheds in the Delaware Basin. This not only links work done locally within the clusters through collaboration across the spectrum of restoration and protection needs for the first time, but it also links organizations working in the headwaters of the Delaware with groups working downstream.

The plans, often 50 to 100 pages each, offer detailed approaches to the stressors and strategies discussed in this paper. These strategies are paired with approaches to tracking progress and failures for potential mid-course correction. In essence, the plans provide a blueprint for public and philanthropic funders seeking to pursue these themes in a framework supported by monitoring, technical assistance and communication.

The William Penn Foundation anticipates supporting four major areas of investment across these eight geographies.

Cross-cutting innovation through financial support of policy, research and market development that furthers restoration and protection across the Delaware River watershed. This work will include a mixture of investments in organizations in specific watershed clusters that are working on issues with broader implications and intermediaries that are providing assistance across the clusters.

Restoration activities will include activities such as stormwater control measures, stream bank stabilization, agricultural best management practices and other capital intensive projects. The watershed cluster plans identified a need of approximately $75 million over the next three years. The William Penn Foundation will seek to support a portion of this work through establishment of a capital fund that will distribute funds for exemplary projects through a competitive grant process.

Protection activities will include direct acquisition of land and easements that make the greatest contribution to maintaining water quality and avoiding future degradation. The watershed cluster plans identified protection needs totaling over $87 million over the next three years to protect critical high quality streams, headwaters and flood plains that might otherwise be converted out of natural use. The William Penn Foundation will seek to support conservation through establishment of a capital fund that will distribute money for the best projects through a competitive grant fund.

Additional needs covering monitoring and constituency-building were identified in the plans, totaling $16 million in funding requests. The William Penn Foundation has already begun investing in monitoring of the watershed with an initial investment with ANSDU and will continue to work with thought leaders in research and applied science to ensure technical assistance and high-quality monitoring across the Delaware Basin, as well as the direct application of research findings towards more effective practice.

In total, the plans identify over $230 million of costs for protection, restoration, constituency-building and monitoring to make measurable headway on water quality over the next three years. They represent the work of strong and knowledgeable nonprofit groups—including large global organizations as well as small citizen watershed groups-working in partnership with key public agencies around shared goals and priorities. While these plans inform investment by the William Penn Foundation, they also identify opportunities for investment that are many times larger than the scope of the Foundation's resources. Partnership from both the private and public sector will be critical to success. The Foundation's commitment to supporting local and watershed-wide monitoring to ensure measurable results and adaptive management, offers other investors a valuable opportunity for learning as well. In this way we aspire to maximize positive impact from all sources, as we work towards greater health, sustainability and resiliency for this essential and irreplaceable resource.

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