Delaware River Watershed Business Plan

National Fish & Wildlife Foundation

March 2017 (Updated 2023) – March 2027

Purpose of a Business Plan

The purpose of a NFWF business plan is to provide a concise multi-year blueprint of the strategies and resources required to achieve the desired conservation outcomes by the end of the plan. This plan incorporates the views of federal, state, academic, and organizational experts consulted during its development and is intended to complement existing efforts in the larger conservation community.

NFWF implements these strategies to generate a measurable conservation impact in a landscape, and NFWF uses progress towards species goals as a measure that healthy, functioning habitat has been restored and that threats can be managed. Although the landscape-scale conservation need is typically greater than the investment from a single business plan, NFWF monitors species response to interventions within the business plan's focal areas to demonstrate that the conservation strategies *can* move the needle on its goals, thus building the case for larger investments in the strategies.

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About NFWF

Chartered by Congress in 1984, the National Fish and Wildlife Foundation (NFWF) protects and restores the nation's fish, wildlife, plants and habitats. Working with federal, corporate, foundation and individual partners, NFWF has funded more than 6,000 organizations and generated a total conservation impact of $7.4 billion. Learn more at www.nfwf.org.

Cover photo credit: *Feeding red knots and dunlin* (iStock photo); *Smooth cord grass and ribbed mussels* (iStock by Getty images); and *Delaware River* (Andrew Kazmierski).

Conservation Need

The Delaware River, at the heart of the densely populated mid-Atlantic region and central to the nation's Northeastern transportation corridor, flows nearly 330 miles from its headwaters in New York to its mouth at the Atlantic Ocean, where it forms the border between New Jersey and Delaware. The Delaware River is recognized nationally and internationally for its exceptional ecologically and historically significant sites. It provides drinking water to over 15 million people, it annually attracts countless tourists, and it drives an economy largely based upon the expansive natural resources of the region.

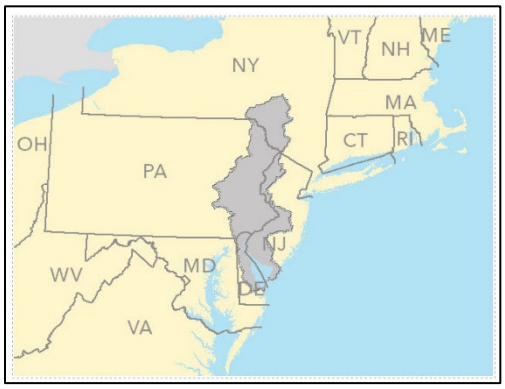


Figure 1. Map of Delaware River watershed.

The Delaware River watershed includes portions of five states, with 13,539 square miles contributing to its watershed (Figure 1). The open water of the Bay comprises 782 sq miles with freshwater inputs from nearly 2,000 tributaries. All or portions of 42 counties and 838 municipalities contribute to and benefit from the watershed.

Since at least the 1600s humans have been altering the landscape, including clearing of forested lands for agriculture; building of canals, roadways, dams; dredging for deeper ports; developing vast industries reliant on water and energy sources; and harvesting lumber and extracting coal. Several times over the past two centuries, migratory fish, birds and oyster populations have been decimated by overharvesting, pollution, hydrologic and hydraulic changes, and consequent dead zones.

Due to pollution abatement and other control measures implemented over the last several decades, populations have begun to rebuild, providing strong evidence of the system's ability to rebound from disturbances. However, the legacy and persistence of land conversion, river corridor disturbances, and the rising sea levels associated with climate and other stressors continue to threaten the sustainability of habitats throughout the Delaware River watershed.

This business plan targets three integral habitat types for restoration and protection that are critical to the Delaware River watershed, its fish, wildlife and people: nearshore, aquatic, and forest. Within each of these habitats, NFWF has chosen focal species that are of conservation concern and/or indicators of habitat improvements that would also benefit a suite of other species reliant on that habitat.

Nearshore Habitat

Defined as the shallow water and land adjacent to the shorelines and stream banks within the Delaware Bay and coastal areas, nearshore habitat includes the beach, intertidal and subtidal zones, as well as the upland area of the shore. With an estimated 232 total coastal miles along the Bay, the interdependency of migratory birds with beaches and food sources is intricately interwoven with functional and resilient saltmarsh systems.

Red Knot. The Delaware Bay's nearshore habitat provides a critical stopover and food source for migratory shorebirds including the red knot (*Calidris canutus*). Eggs spawned by millions of horseshoe crabs (*Limulus polyphemus*) on beaches in May provide the key energy source that makes this location a

critical stopover site; the availability of abundant horseshoe crab eggs directly correlates with the survival of red knots (USFWS 2013). Overall, Delaware Bay nearshore habitat is critical for a suite of migratory and coastal bird species, like semipalmated sandpiper (*Calidris pusilla*) and ruddy turnstone (*Arenaria interpres*). The harvest of horseshoe crabs for bait, the loss of beach habitat for spawning crabs, human disturbance, and the extraction of blood from live adult horseshoe crabs for pharmaceuticals all affect the availability of the red knot's food source.

Saltmarsh Sparrow. Despite the widespread distribution of tidal wetlands throughout the Delaware estuary, marsh habitat is rapidly disappearing and currently only occupies an estimated five percent of its historical range. With over 63 percent of examined marshes experiencing net erosion, estimates indicate that from 1996 to 2006 tidal wetlands throughout the estuary experienced a net loss of approximately an acre per day. As salt marsh habitat is lost, salt marsh-dependent species are increasingly vulnerable, including the saltmarsh sparrow (*Ammospiza caudacuta*).

Saltmarsh sparrows are tidal marsh obligates that breed exclusively in high marsh habitats from Virginia to Maine (Hartley & Weldon 2020). Nests are constructed in salt marsh grasses just above mean high-water level, making them vulnerable to flooding due to sea level rise and the loss of high-quality breeding habitat that has been converted to unsuitable low marsh or open water habitat. As the frequency, duration, and magnitude of tidal flooding has increased, saltmarsh sparrow populations have declined 9% annually since 1998 to an estimated 60,000 individuals in 2011-2012 (Wiest et al. 2016, 2019). Species experts predict saltmarsh sparrows will decline to critically low levels if sufficient high-quality habitat is not maintained to support successful breeding (Hartley & Weldon 2020).

Aquatic Habitat

From forest headwaters to the downstream river and estuarine systems, a continuum of water environments creates valuable and diverse habitat supporting a wide array of aquatic life. With 23,700 linear miles of streams and rivers, and expansive groundwater systems underlying them, the availability and quality of water is critical not only for the region's water demands, but also for supporting the aquatic health of representative fish species like eastern brook trout (*Salvelinus fontinalis*) and an assemblage of alosine species such as American shad (*Alosa sapidissima*) and river herring (a group of two species: alewife, *A. pseudoharengus* and blueback, *A. aestivalis*).

Water Quality. The availability of high-quality water across the Delaware River watershed is essential to the 15 million people who depend upon it as their source of drinking water and for the welfare of both aquatic and terrestrial wildlife. Degraded water quality is caused by a combination of historic point sources (e.g., industrial waste, acid mine drainage, wastewater treatment plants), as well as more diffuse nonpoint sources. Runoff from urban and agricultural lands delivers nutrient, bacterial and sediment pollution to streams throughout the region. Stormwater runoff from impervious, urbanized areas has diminished water quality by altering the temperature regime, depleting dissolved oxygen and introducing roadway and other surface contaminants to streams. These pollution inputs seriously impact sensitive species like eastern brook trout and the macroinvertebrates they rely upon as a food source. The sheer velocity and volume of stormwater strips the hydraulic and hydrologic function of streams, greatly reducing the assimilative capacity of the region's waters and diminishing overall health of stream and river systems.

Eastern Brook Trout. Historians credit the upper Delaware River as the birthplace of American fly-fishing on account of the prolific populations of eastern brook trout. In fact, nineteenth century overfishing in the Catskills was cited as the cause for the original decline in the native trout population within the

Delaware River watershed at the turn of the century. Eastern brook trout persist in only the coldest and cleanest waters and are excellent indicators of good water quality and watershed health. Indeed, poor water quality and impairments to hydrology and habitat are the main reasons for brook trout population declines. Climate-induced warming may increase stream temperatures and further alter stream hydrology therefore reducing the amount of habitat available for brook trout in the basin. Fragmentation from dams and impassable culverts results in small eastern brook trout populations that are more vulnerable to disturbance events (floods, drought) and population bottlenecks where genetic diversity is reduced. Brook trout are also threatened by non-native trout, which out-compete brook trout for food and spawning sites and routinely prey upon them. The mid-Atlantic region, including the Delaware River watershed, has experienced some of the greatest of historical declines in brook trout populations across their native range (EBTJV 2023).

Alosine Species. The river basin is home to ten diadromous fish species that migrate between freshwater and marine habitat, including three formerly abundant alosine species represented by two species of river herring, alewife and blueback, and American shad. Historically, alosine species are thought to have utilized many, if not all, medium to large tributaries of the Delaware River watershed and were among the region's most abundant and economically valuable fishes. While little is known about the number of adults that return to Delaware River tributaries to spawn and how they utilize available habitat, populations of American shad and river herring have declined significantly over the last century. Alosines' migratory life cycle is dependent upon unrestricted access to high-quality upstream spawning habitat, but several factors have diminished this access including barriers on tributaries, overfishing, pollution, and habitat alteration and channelization for shipping or flood control, and the loss of natural shoreline that changed flow patterns.

Forest Habitat

The forests that once dominated the Delaware River watershed provided vast, contiguous habitat that nurtured numerous bird species as well as other terrestrial and aquatic species. Today, just under 50 percent of the Delaware River basin's upland is forested but much of it is fragmented, with isolated patches surrounded largely by encroaching development.

In a landmark publication, Rosenberg et al. (2019) analyzed 48 years of Breeding Bird Survey data (from 1970-2018) and reported a nearly 3 billion bird decline or 29% of the 1970 bird abundance across the continental U.S. and Canada. Losses spanned multiple breeding biomes with the eastern forest region suffering from a nearly 30% decline in overall bird abundance. In this region, the decline of habitat specialists including golden-winged warbler (*Vermivora chrysoptera,* 60% decline), wood thrush (*Hylocichla mustelina,* 59% decline), and cerulean warbler (*Setophaga cerulea,* 73% decline) is symptomatic of habitat loss and fragmentation that have dramatically reduced habitat suitability.

A healthy forest mosaic exists when bird species that are known to represent the discrete stages of forest succession are present and fully utilizing breeding territories. For example, golden-winged warbler are dependent on early successional forest for the nesting portion of their annual cycle. Wood thrush require mature forest for establishing successful breeding territories, and cerulean warblers are dependent upon a heterogeneous open canopy indicative of late successional forests. However, these species are at risk due to incompatible land practices, fragmentation, or forest management that focuses on a single attribute instead of the diverse age and structure needed within the forest.

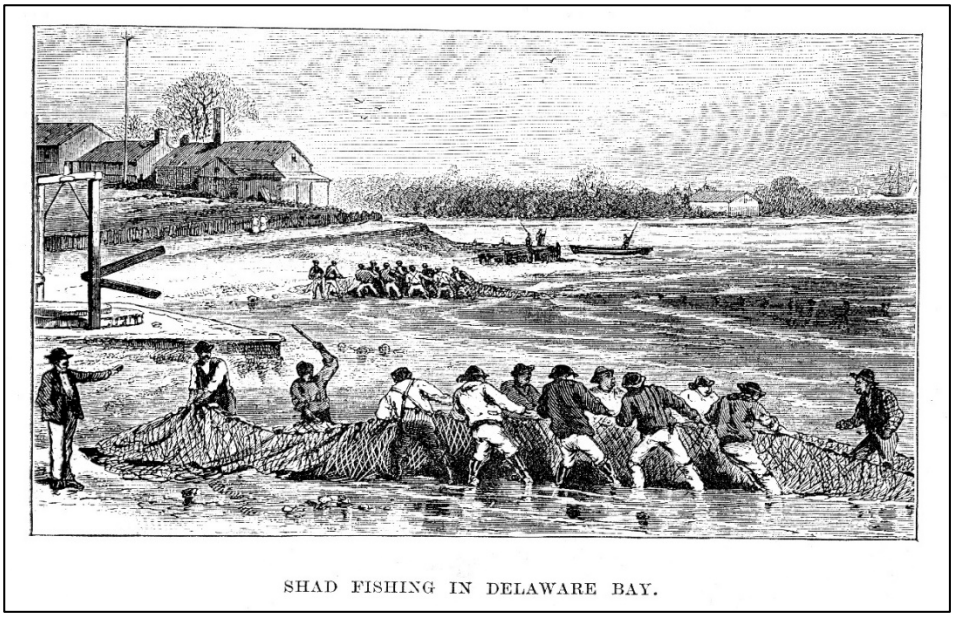
Current Conservation Context

Through its Delaware River Program, NFWF participates in two significant collaboratives dedicated to conserving and restoring the Delaware River and Bay's natural resources for the benefit of fish and wildlife, and the people who live within the watershed. The first is a decade-long collaboration spearheaded by the William Penn Foundation, the Institute for Conservation Leadership, the Open Space Institute, and the Academy of Natural Sciences along with 50 nonprofits across the Delaware River watershed to improve water quality with the overarching goal of ensuring the future of clean, abundant water for all aspects of life in the watershed. The William Penn Foundation invests in the capacity of non-profit organizations to protect and restore water and ensure clean, abundant water for present and future generations. NFWF's Delaware River Watershed Business Plan complements this work by expanding the scope to emphasize habitat protection and restoration, which benefits species.

The second major initiative was launched in response to the Delaware River Basin Conservation Act (DRBCA) that was signed into law in 2016. The DRBCA authorized the U.S. Fish and Wildlife Service (USFWS) to create a framework for Delaware River basin restoration and to establish a grant program to support implementation of the framework. The USFWS partnered with NFWF to deliver this new comprehensive program, which has seen a steady increase in funding each year since its inception.

In addition, national and international efforts to track and conserve migratory shorebirds and diadromous fishes have established conservation goals that include the Delaware Bay and the unique habitat and role it plays within the Atlantic flyway for shorebirds and the life cycles of American shad and river herring. This business plan integrates and augments the goals of national and regional partners to maximize opportunities to leverage programs and funding towards the success of these species.

Figure 2. Source: iStock, historical. Used with permission.



SHAD FISHING IN DELAWARE BAY.

Conservation Outcomes

The Delaware River Watershed Business Plan takes a multi-species approach to improve and sustain nearshore, aquatic, and forest habitat in combination with improved water quality in targeted geographies across the basin. The overarching vision is to:

> *Restore and protect the diverse natural resources of the Delaware River watershed, from the headwaters to the Bay, to sustain healthy, interconnected populations of fish and wildlife, their natural habitat, and the water quality upon which they depend.*

Based on scientific literature and extensive expert input, investments directed to the conservation goals (Tables 1-3) are expected to achieve broader ecosystem benefits for native fish and wildlife and water quality in targeted geographies (Figures 3-5)[1] and at scales within which assessment of change over time can occur.

Nearshore Habitat

The Delaware River Watershed Business Plan includes two focal species as indicators of ecosystem health within nearshore habitats. Business plan goals for these species are listed in Table 1 and focal areas for investment are shown in Figure 3.

Red knot. Through this business plan NFWF will address threats impacting the quality and availability of nearshore beach habitat that supports spawning horseshoe crabs (HSC) and migratory shorebirds with a focus on red knot. The long-term goal is to increase the fitness and population of red knots visiting Delaware Bay in May. NFWF aims to achieve this goal by restoring four miles of nearshore beach habitat and reducing human disturbance through outreach and a beach steward program. Beach restoration is anticipated to result in horseshoe crab egg densities approaching 50,000 eggs/sq/m. Along with activities to reduce human disturbance on beaches, this should lead to improved fitness for red knot, as measured by the proportion of individuals that reach a threshold weight of 180g before departing Delaware Bay for the Arctic to initiate breeding.

Saltmarsh sparrow. The business plan aims to build a stable population of saltmarsh sparrow by increasing bird density within priority salt marshes across Delaware Bay. The conservation community's long-term goals are to stabilize and increase the population to 25,000 birds by providing 80,000 acres of high marsh habitat throughout the breeding range by 2070 (Hartley & Weldon 2020). Restoring high-quality, functional salt marsh habitat will benefit saltmarsh sparrow and other salt marsh-dependent species, will sequester carbon, and will provide resilience benefits to coastal communities facing increasing flood-related threats. NFWF seeks to restore at least 1,500 acres of saltmarsh habitat within priority patches as identified by the Atlantic Coast Joint Venture and partners[2], which contributes to the short-term habitat targets in the Delaware Bay needed to help stabilize the population and reverse rapid annual decline rates (Hartley & Weldon 2020).

[1] Business plan priority geographic areas can also be found in this interactive map.

[2] Saltmarsh Restoration Priorities for Saltmarsh Sparrow: https://experience.arcgis.com/experience/2d84851dfed24ae79d510e6e62ddcb66?data_id=dataSource_2-FWS_ACJV_SHARP_regional_survey_points_from_2011_2014_1076%3A1443

Table 1. Conservation goals for nearshore habitat focal species.

Focal Species	10-yr Business Plan Goals
Red knot	Maintain the population of red knots using Delaware Bay during spring migration.[3]
Saltmarsh sparrow	Maintain or increase density (individuals/acre) at restored patches (density is highly variable - see Appendix A for baseline density estimates for focal salt marshes in the Delaware Bay).

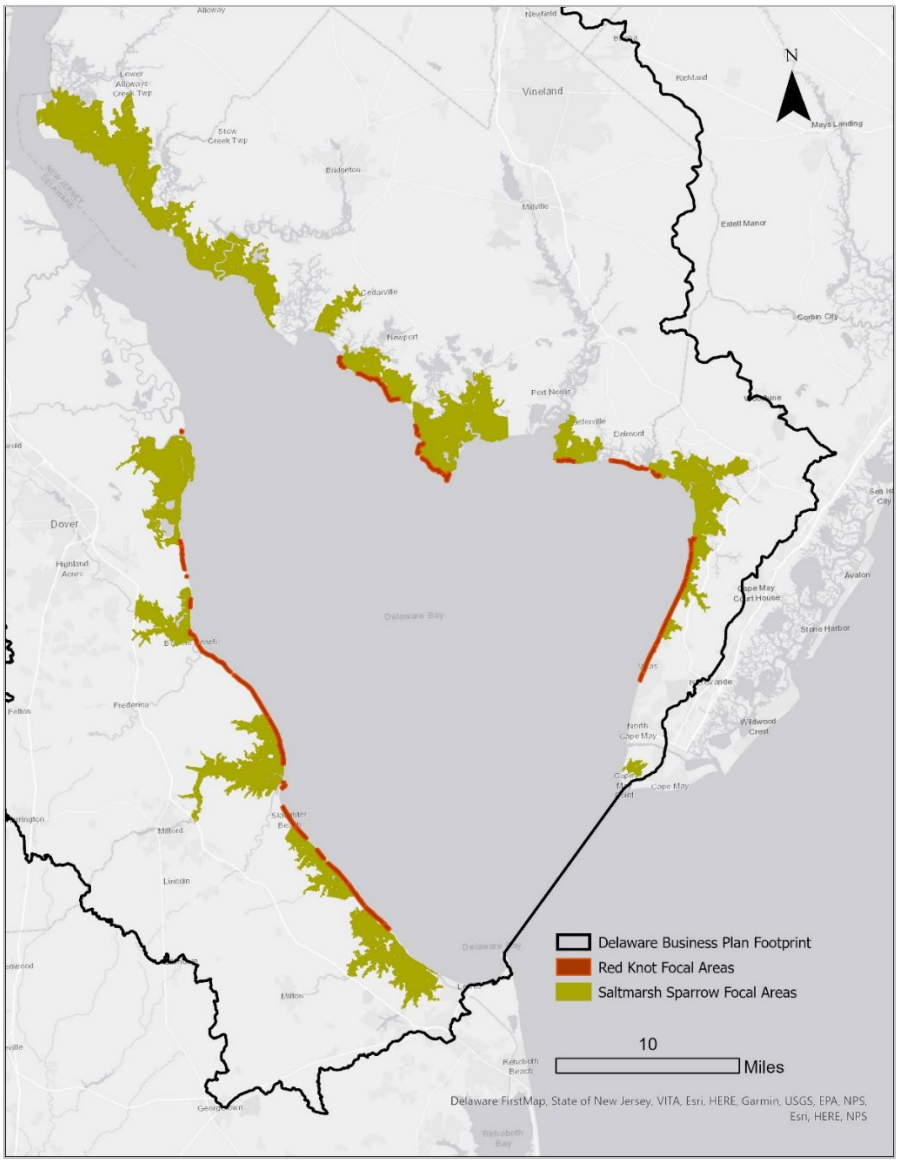


Figure 3. Delaware River watershed with priority habitat for nearshore species.

[3] Recent Delaware Bay red knot counts indicate variation in the number of birds using the system. The number of red knots in the Bay increased above the 2016 baseline to a high of more than 32,000 individuals in 2018, followed by a decrease through 2021 when only 7,000 individuals were recorded. Numbers then increased to more than 12,000 in 2022. These recent fluctuations in the Delaware Bay counts generate uncertainty about the population trajectory, which is reflected in this updated goal to maintain the 2017 baseline of red knots using Delaware Bay.

Aquatic Habitat

This business plan includes two focal species as indicators of ecosystem health within aquatic habitats. Business plan goals for these species are listed in Table 2 and focal areas for investment are shown in Figure 4.

Eastern brook trout. The business plan aims to improve eastern brook trout habitat in seven priority patches. NFWF intends to increase relative abundance via a full suite of restoration practices in five of the patches. Restoration in the remaining two patches will maintain the existing brook trout populations. NFWF will invest in riparian restoration, aquatic organism passage improvements, in-stream restoration, and land protection of high value patches within the focal areas. Restoration and protection within the Delaware River watershed will contribute to resilient brook trout populations.

Alosine species. The plan aims to restore access to alosine spawning and nursery habitats within focal rivers throughout the Delaware River watershed. Barriers to fish migration prevent American shad and river herring from reaching high-quality habitats and hinder population growth. By prioritizing fish passage projects within focal rivers, the plan will allow American shad and river herring to utilize over 200 miles of historic, high-quality spawning and nursery habitats. Over time, improved habitat connectivity will contribute to increased annual spawning runs.

Table 2. Conservation goals for aquatic habitat focal species.

Focal Species	10-yr Business Plan Goals
Eastern brook trout	1) Demonstrated increase in eastern brook trout relative abundance in five persistent or stronghold patch types and 2) maintain relative abundance by improving habitat in two additional persistent or stronghold patches.
Alosine species	Ensure at least 200 miles of priority streams are occupied[4] by alosine species by improving aquatic habitat connectivity for American shad and river herring.

[4] Stream miles occupied are calculated using the full upstream functional network above priority dams to be rectified; monitoring efforts will confirm habitat utilization above rectified barriers under the assumption alosine species may potentially occupy the full extent of the upstream function network opened.

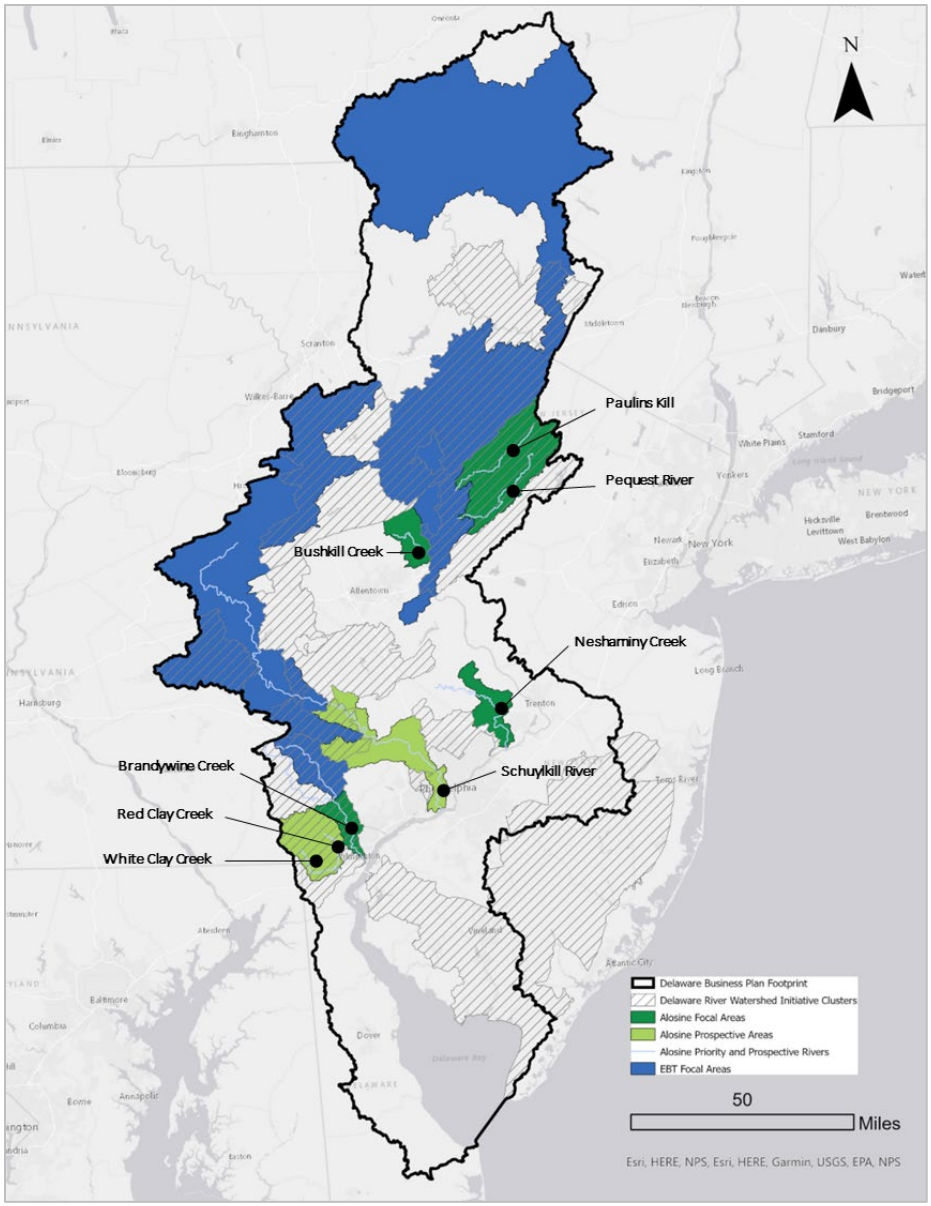


Figure 4. Delaware River watershed with priority habitat for aquatic species and targeted watersheds for water quality.

Forest Habitat

This plan includes three focal bird species as indicators of ecosystem health within forest habitats. Business plan goals for these species are listed in Table 3 and focal areas for investment are shown in Figure 5.

Forest birds. Through the business plan NFWF will support planning and implementation of strategies to improve the age and structural diversity of contiguous blocks of forest greater than 5,000 acres for bird and wildlife species. The objective is to develop forest management plans and implement treatments to facilitate a dynamic and shifting mosaic of forest age classes within a forest block over time. This will provide an appropriate mix of habitats to meet the requirements of forest birds, with a focus on three

declining species (golden-winged warbler, wood thrush, and cerulean warbler). Breeding territory goals were derived from data on the minimum territory size required for nesting and as a function of the total acres implemented by forest stage (age class).

Table 3. Conservation goals for forest habitat focal species.

Focal Species	10-yr Business Plan Goals
Golden-winged warbler	Manage forest habitat to support 300 breeding territories.
Wood thrush	Manage forest habitat to support 1,400 breeding territories.
Cerulean warbler	Manage forest habitat to support 1,600 breeding territories.

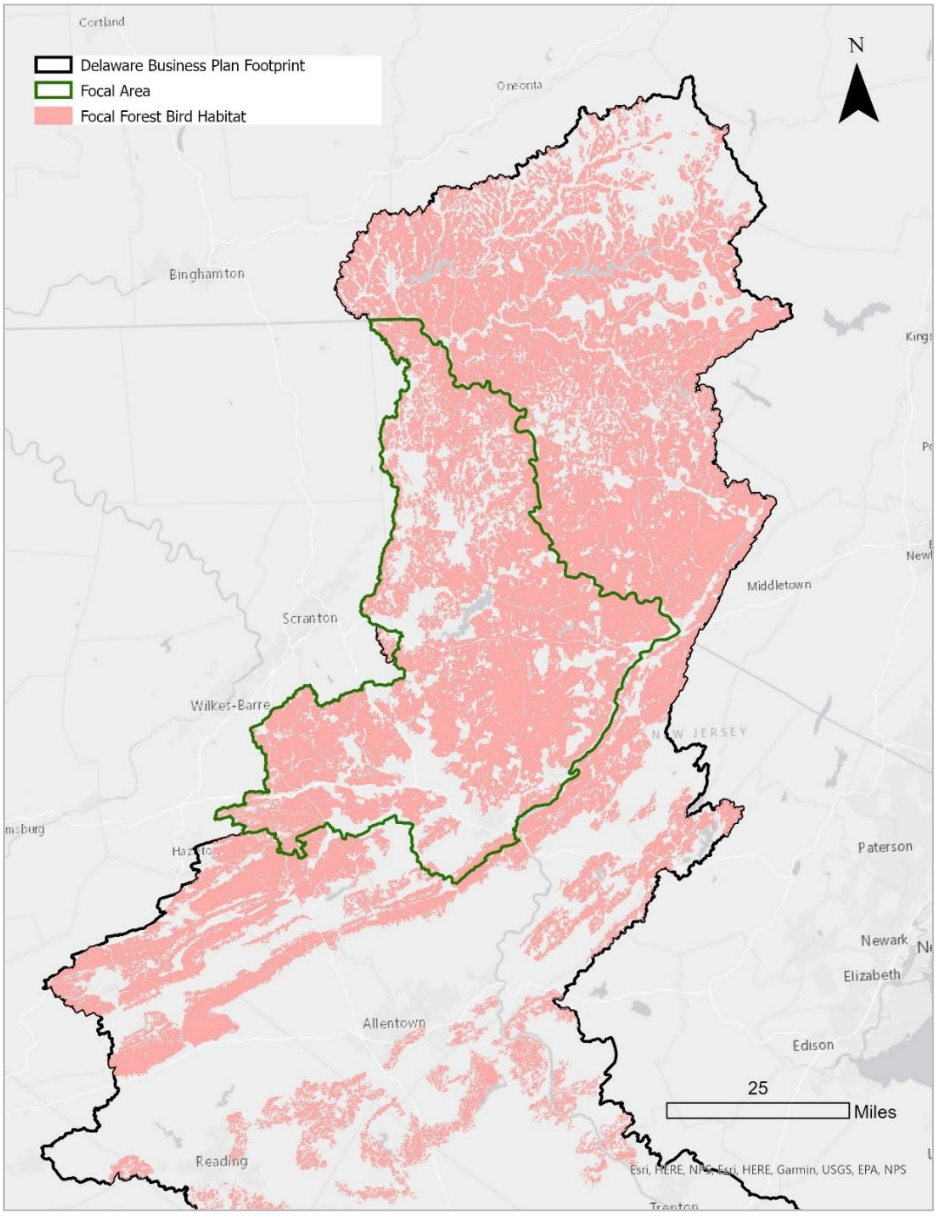


Figure 5. Delaware River watershed with priority habitat for forest species.

Implementation Plan

The Delaware River Watershed Business Plan strategies are designed to improve the quality and resilience of nearshore, aquatic and forest habitats critical to the viability and future of the region's diverse shorebirds, migratory fish, native trout, and forest dwelling birds. While the strategies are presented by habitat category, in many cases activities may result in conservation outcomes across a range of habitat and species. The results chain in Figure 6 provides a model for how the collective strategies are predicted to contribute to the identified conservation outcomes.

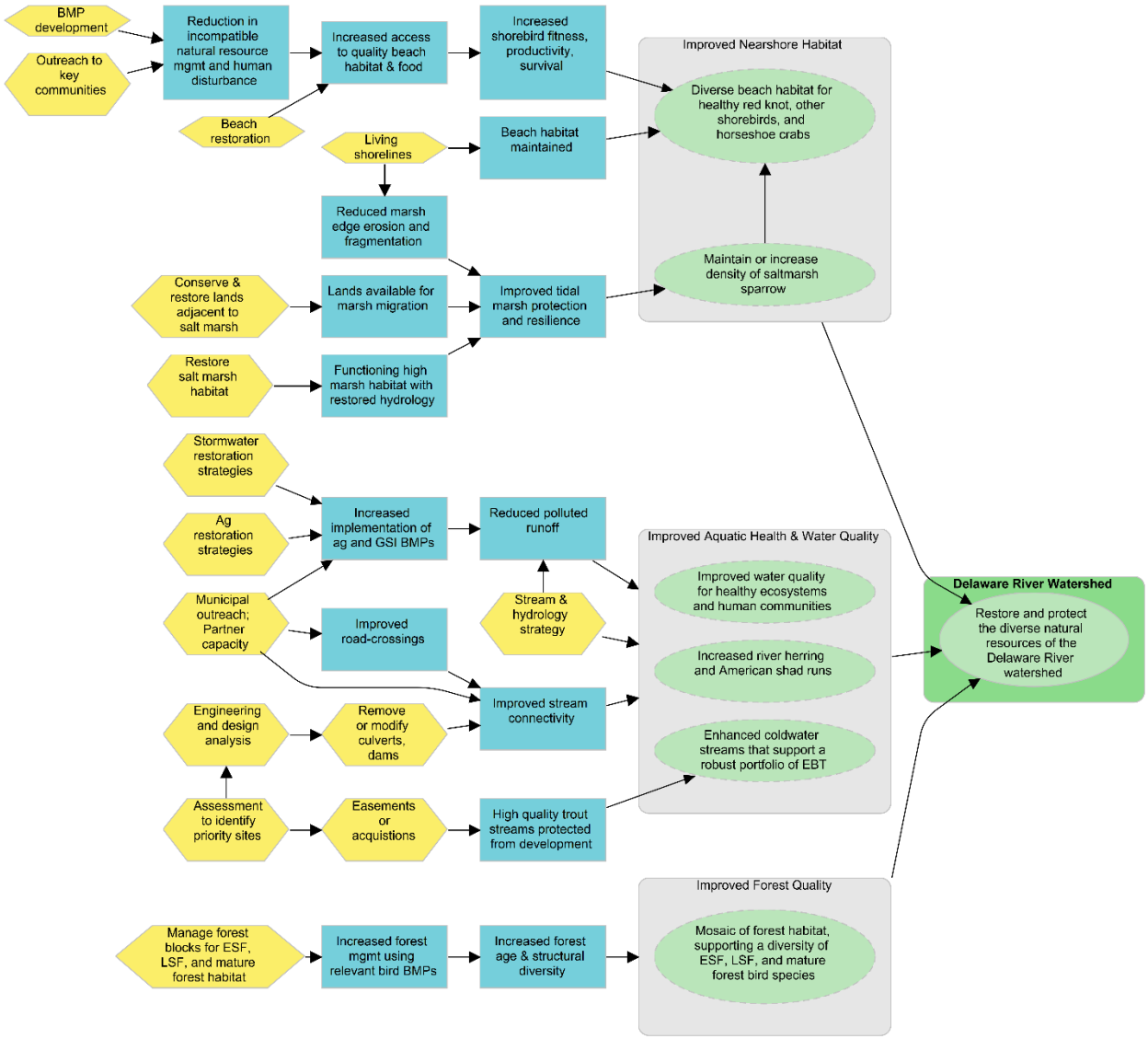


Figure 6. Results chain depicting the relationship of strategies (yellow hexagons) to the intermediate results (blue boxes) and ultimately to the business plan focal species (green ovals).

Strategy 1: Restoration and Management of Nearshore Habitat

Red Knot

1.1 Increase high-quality beach habitat at priority roosting and foraging sites through the restoration and enhancement of four miles of beach habitat that has been altered or destroyed during recent storm events. Restoration and enhancement can include establishment of best management practices (BMPs) for restoration and placement of living shorelines and oyster reefs to reduce winter erosion and protect horseshoe crab spawning habitat.

1.2 Reduce impacts of human and wildlife disturbances to critical red knot habitat areas through a beach steward program and development of a community outreach and social marketing program to increase awareness about the importance of beaches to red knot and other species during critical staging period between May and June. The public outreach will be targeted to areas with known roosts: Egg Island Point and Bombay Hook.

1.3 Research and monitoring shorebird success. Conduct an annual census of red knot and other shorebirds throughout the Bay. Support the census and mapping of horseshoe crab populations in and adjacent to the Bay to ensure reliable data are being collected and are available for determining their management.

Saltmarsh Sparrow

1.4 Identify priority sites for the construction of living shorelines. Initial investments in the business plan allowed for the identification of high priority sites for prioritizing future conservation investments so this strategy is not anticipated to receive further NFWF investment in this updated business plan.

1.5 Monitoring to evaluate salt marsh restoration success. Monitoring is critical to evaluate the effectiveness of different salt marsh habitat restoration and protection activities. Prior to and following restoration, sites will be monitored using the standardized Saltmarsh Habitat and Avian Research Program (SHARP 2023) protocols to determine the presence and density of saltmarsh sparrows. These data will help inform which strategies are most effective at promoting saltmarsh sparrow recovery. Monitoring will inform the implementation of the business plan and assist resource managers, researchers, and conservation practitioners throughout the Delaware estuary to choose the most effective methods for stemming marsh loss and increasing saltmarsh sparrow densities. Results from these monitoring efforts will also help to identify critical gaps and opportunities for research and development to refine methodologies and enhance conservation outcomes.

1.6 Improve and increase high-quality salt marsh through habitat restoration and protection. Restore native vegetation and hydrologic function to priority salt marsh complexes, and where appropriate create microhabitats to support saltmarsh sparrow nesting sites. Functioning salt marsh complexes allow tide waters and storm surge to inundate and exit the marsh system without becoming trapped and provide natural sedimentation that replenishes marsh elevation. Activities may include engineering and design plans, ditch remediation, runneling, sediment placement, modifying tidal restriction (e.g., culverts, berms), restoring native vegetation, and improved management and agricultural practices. The plan also aims to maintain high-quality salt marsh habitat through land protection via easements or acquisitions, and erosion control measures. Activities may include installing living shorelines to reduce marsh loss and

fragmentation while protecting important shoreline habitats and bolstering shellfish populations. Actions may also include conservation and restoration of freshwater wetlands, forests, and agricultural lands adjacent to large salt marsh systems to provide a transition zone and facilitate marsh migration.

Strategy 2: Restoration and Management of Aquatic Habitat

Water quality and quantity

2.1 Reduce the impact of polluted runoff on water quality and stream hydrology. For agricultural lands, conduct assessments and develop conservation plans that result in accelerated implementation of BMPs like forested riparian buffers, stream livestock exclusion, and improved barnyard management. Stabilize streambanks (where appropriate), reconnect streams to floodplains, and enhance and restore wetlands to improve the assimilative capacity and overall resiliency of streams. For developed areas, assess the opportunities for green stormwater infrastructure (GSI) and implement practices that will enhance infiltration, reduce polluted runoff, and diminish the overall volume and energy of stormwater. GSI practices may include rain gardens, bioswales, green roofs, riparian buffers, basin retrofits, and wetland restoration. Remediate streams where acid mine drainage prevents the stream from meeting its designated use for aquatic life.

2.2 Increase partner capacity to accelerate water quality improvements through technical assistance, volunteer development, and municipal engagement. Improve outreach and technical assistance to farmers and other landowners. Engage citizens in supporting economic and policy incentives that promote watershed health including ordinances, zoning, and planning that increase both the adoption of agricultural best management practices and GSI at the household and municipal levels. Develop volunteers to engage in conservation and restoration projects where feasible.

Eastern brook trout

2.3 Restore connectivity in streams that support eastern brook trout (EBT) populations. Assess patch fragmentation to develop finer scale information needed to identify priority passage barriers. Remove small dams and replace impassable culverts with passable structures to increase high value patch size. Proactively engage federal and state transportation agencies, local townships and municipalities to design road crossings appropriately to enable fish passage and to prevent road blowouts from extreme storm events. Work with governmental partners to ensure that interventions in response to flood damage maintain or enhance lateral and longitudinal stream connectivity.

2.4 Restore habitat, water quality, and hydrology in streams that support EBT populations. Urban and agricultural runoff, acid mine drainage, roads, and the alteration of upland and riparian areas result in water quality, hydrology and habitat impairments that reduce brook trout population resiliency. Addressing these impairments through restoration and BMPs in targeted high value patches will support the overall resiliency of EBT-occupied streams and will help EBT populations adapt to the added stress of climate-induced stream warming and hydrologic change. Additional activities that support this strategy are identified in the water quality section, 2.1.

2.5 Identify and protect high-quality native trout patches from future development and related disturbances. Many streams in the Delaware basin have not been surveyed for fish. Residential,

commercial, and energy-related development, including the increase of roads, culverts, and stream crossings, are expected to continue and possibly accelerate in the Delaware basin, impacting high-quality brook trout populations through land conversion and hydrologic alteration. Continue assessment programs that target streams likely to support EBT, but where fish populations have not been previously confirmed. Support conservation easements or fee-based acquisition of stronghold patches within focal areas.

2.6 Establish a robust monitoring program for the key EBT patches where NFWF and partners plan to invest in restoration. Adequate and spatially explicit monitoring will ensure that brook trout population response to restoration investments is measurable. Develop an EBT population monitoring design in priority patches. Implement this design to establish a relative abundance baseline brook trout. The monitoring program will measure the expected increase in relative abundance in targeted high value patches.

Alosine species

2.7 Identify priority sites for restoration. To restore aquatic connectivity for alosine species within the Delaware basin, it is critical to first assess habitat suitability and characterize any barriers or impediments that are currently preventing American shad and river herring from reaching or fully utilizing high-quality spawning habitat. Through initial investments in the first year of the business plan, criteria will be established and analyzed to identify priority sites to target restoration investments and maximize conservation outcomes.

2.8 Establish and/or improve monitoring programs for alosine species. Support monitoring efforts to confirm the presence of adult American shad, alewife, and/or blueback herring following the removal of priority barriers. Monitoring efforts should utilize established monitoring techniques such as electrofishing to obtain visual confirmation of adults utilizing newly opened habitat. Where possible, additional monitoring should support population-level assessments to understand the number of spawning adults utilizing priority rivers annually.

2.9 Restore access to spawning habitat by increasing connectivity in priority rivers. Improve fish passage by removing or installing fishways over priority dams. Fish passage improvement efforts may also include initial site assessment, fish passage efficiency studies, and the development of initial and final engineering and design plans for barriers on priority and prospective rivers.

2.10 Support and build community outreach and education about alosine species and habitat requirements through citizen science and intergenerational and youth engagement projects. Offer educational opportunities that engage all ages around the goals and expected outcomes of alosine restoration projects.

Strategy 3: Management of Forest Habitat

3.1 Develop forest plans and implement forest management to improve age and structural diversity within blocks of contiguous forest of at least 5,000 acres in size. Lands will be prioritized where coordinated management of contiguous forest blocks is possible. Utilize established BMPs to plan and implement a mosaic of mixed-aged forest that provides suitable habitat for focal bird species. Conduct outreach and deliver technical assistance to private landowners with lands adjacent to, between and within anchor public lands, targeting family-owned woodlands, industrial/commercial forests, and other private forest parcels.

3.2 Create and manage a portion of each forest block for early successional forest (ESF). Manage 15% of each forest block for ESF. Patch size and distribution across the landscape will need to be carefully planned to account for habitat senescence and bird dispersal. Develop and implement ESF management using BMPs developed for golden-winged warbler (Bakermans et al. 2011).

3.3 Manage a portion of each forest block for a transitional mature forest (i.e., standard oak silviculture methods). Manage 50% of each forest block for structurally diverse mature forest conditions. Implement BMPs for mature forest management to benefit wood thrush and additional species (see Guidelines for Managing Wood Thrush and Scarlet Tanager Habitat in the Northeast and Mid-Atlantic Regions, Lambert et al. 2017).

3.4 Create and manage a portion of each forest block for late successional forest (LSF). Manage 35% of each forest block for LSF habitat; implement LSF management plans including implementation of cerulean warbler BMPs (Wood et al. 2013). Overall, the management footprint for LSF habitat will be light, with forests "allowed" to age "naturally" utilizing tools like invasive species control, prescribed fire, or other light forest stand improvement activities. These acres will benefit multiple species, including wood thrush and cerulean warbler, as age and structural diversity are improved.

3.5 Monitor focal bird species within the established forest blocks. Through monitoring NFWF will establish baseline focal species estimates using point count sampling (Ralph et al. 1995) and passive acoustic recording units (ARUs). Focal bird abundance, density, and occupancy will be monitored as forest management activities are undertaken and within control sites. Forest management goals (acres per habitat type) will be tracked through grantee reporting and stand maps.

Risk Assessment

Risk is an uncertain event or condition which, if it occurs, could negatively affect a plan's outcomes. NFWF assessed seven risk categories to determine the extent to which they could impede progress towards the strategies and goals for the Delaware River Watershed Business Plan during the next 10 years. Table 4 lists the primary risks to success and the strategies that NFWF will implement to minimize or avoid those risks, where possible.

NFWF also considers how these risks might affect the long-term sustainability of the outcomes achieved (i.e., up to 10 years after closure of the plan). To support long-term sustainability, NFWF engages in the following best practices:

- **RFP:** Any Request for Proposals for the business plan will notify applicants that projects should anticipate post-implementation monitoring by future NFWF grantees or contractors. The RFPs will also list long-term sustainability in the evaluation criteria section.
- **Outreach:** NFWF will support conservation projects that engage directly with landowners and local communities to build sustained support for implementation and maintenance.

Table 4. Business plan risk assessment summary.

Risk Category	Rating	Risk Description	Mitigating Strategies
Economic Risks	**Low**	Bycatch occurring outside of the plan footprint may impact alosine populations that could occupy expanded spawning areas. Horseshoe crabs are harvested for bait and bleeding, which impacts red knot but is outside the scope of the plan. Risk that budget is insufficient to achieve goals because costs of materials continue to increase substantially.	Updated business plan goals developed with cost buffer in mind.
Environ-mental Risks	**Mod**	Risk that climate-related impacts, such as sea level rise and more intense storms, contribute to higher loss of tidal marsh and shoreline than expected. Water temperature changes can cause horseshoe crabs to spawn earlier or later, disrupting synchronicity of food availability for red knot.	The plan's living shoreline strategy should increase resiliency at priority marsh sites, but the risk for red knot in particular is high.
Financial Risks	**Low**	Match requirements could be a barrier for applicants.	Program is exploring flexibility in how match requirements are met.
Institutional Risks	**Low**	Risk of insufficient coordination and collaboration required to successfully implement the strategies, considering that multiple organizations have responsibility and missions associated with the plan's outcomes.	Plan includes strategies for organizational collaboration, as appropriate.
Regulatory Risks	**Low**	Infrastructure modifications made in response to increased storms and flooding events may negatively impact restored areas by diminishing connectivity and exacerbating EBT habitat loss. Permitting challenges could delay marsh restoration and dam removals beyond the business plan timeframe.	Outreach to local agencies with flood response responsibilities is a strategy for EBT. NFWF separates design/ permitting grants from restoration and encourages applicants to work early with permitting agencies to ensure a project is shovel ready before receiving restoration funding.
Scientific Risks	**Low**	Uncertainty about impacts on red knots from both offshore wind development and peregrine falcons.	Fund investment in tagging to understand bird movements.
Social Risks	**Low**	Lack of community or landowner support could limit ability to implement needed conservation actions (e.g., dam removal, reducing human disturbance on beaches).	Plan invests in outreach and social marketing strategies for engaging local communities on the value and benefit of conservation actions.

Monitoring & Evaluating Performance

Performance of the Delaware River Watershed Business Plan will be assessed at both project and program scales. At the project scale, **individual grants** will be required to track relevant strategy and habitat metrics from Table 5 to demonstrate progress on project activities and to report out on them in their interim and final programmatic reports.

Table 5. Business plan metrics from individual grants.

Strategy	Outcome	Metrics	Baseline (2017)	Goal (2027)
Nearshore Habitat				
Strategy 1. Restoration and Management of Nearshore Habitat	Increase high-quality horseshoe crab habitat so red knot reach optimum body weight threshold	Miles of restored beach	0	4
	Reduce human disturbance to migratory shorebirds during spring migration	Miles with human disturbance reduction BMPs implemented	0	8
	Protect and restore priority marsh habitat for saltmarsh sparrow	Acres of salt marsh with project design & permitting completed	0	2,000
		Acres of salt marsh restored	0	1,500
Stream and Riparian Habitat				
Strategy 2. Restoration and Management of Aquatic Habitat	Reduce polluted runoff in eight targeted watersheds	Lbs. of nitrogen avoided	0	300,000
		Lbs. of phosphorus avoided	0	93,000
		Lbs. of excess sediment avoided	0	5,900,000
		Acres of agricultural BMPs	0	23,500
		Acres of green stormwater infrastructure BMPs	0	180
	Instream restoration (i.e., woody additions) to enhance EBT habitat	Miles of stream restored	0	20
	Riparian restoration (100-foot width minimum) for EBT	Acres of riparian restoration	0	21,800
		Miles of stream with riparian restoration	0	150
	Restore access to priority alosine spawning and EBT habitat by removing barriers to connectivity	Miles of stream opened	0	205
		Barriers assessed and/or with design plans	0	42
		Barriers rectified	0	24
Forest Habitat				
Strategy 3: Management of Forest Habitat	Develop Dynamic Forest Restoration Block (DFRB) management plans to guide implementation	Acres covered by dynamic forest management plans for age and structural diversity	0	140,000
	Implement forest management to improve age and structural diversity	Acres under improved forest management	0	18,000 acres[5]

[5] Implementation will follow DFRB guidance with 15% of total acres implemented in early successional forest (2,160 acres), 50% in mature forest (9,000 acres), and 35% in late successional forest (6,840 acres).

At the program scale, **species outcomes** from Table 6 will be monitored through targeted grants to key monitoring partners, existing external data sources, and/or aggregated data from grant projects, as appropriate. Priorities for monitoring grants will be included in annual RFPs under this plan. Where possible, monitoring efforts will be coordinated across species. See Appendix A for more detail.

Nearshore Habitat. Restoration of nearshore habitat and the species that depend on it will be monitored by the Delaware Bay Shorebird Project, state and federal wildlife agencies, the USGS Digital Shoreline Analysis System, other site-specific monitoring, and grantees.

- *Red knot:* To determine whether the number and condition of red knots using Delaware Bay has increased, NFWF will fund an annual assessment of long and short distance red knot populations estimated through direct counts, health, and an index of horseshoe crab (HSC) abundance. The health of migrating red knots is measured by their body weight of captured individuals just prior to departure from the Bay. The pre-departure body weight threshold for survival and breeding is P180 (or 180 grams). Experts project that if 80% of red knots meet this threshold, species recovery goals will be achieved. Currently only 40% of red knots departing the Bay reach the threshold; thus, NFWF's goal is a step towards a recovery that will continue beyond the life of the plan. The index of HSC abundance is based on egg densities along priority beaches. Historical data indicate that HSC egg densities exceeded 100,000 per sq meter during the period when red knot numbers were at historical highs (1990s). Experts suggest that recovery of red knots requires a minimum of 50,000 HSC eggs/sq/meter—a value that has not been achieved in more than a decade.
- *Saltmarsh sparrow*: Restoration activities occurring within focal saltmarsh sparrow patches will be monitored to detect patch-level changes in occupancy and density over time. Prior to and following restoration activities, sites will be monitored using the standardized Saltmarsh Habitat and Avian Research Program (SHARP 2023) protocols to determine the presence of saltmarsh sparrows within a patch and if present, to estimate density through point count surveys. In addition to monitoring birds, vegetation, marsh elevation, unvegetated-vegetated marsh ratio, and other biotic and abiotic metrics will also be gathered where possible. Baseline density estimates for all priority patches is provided in Appendix A.

Aquatic Habitat and Water Quality. Monitoring to assess response to the plan's strategies will include species level monitoring that integrates standardized methods and emerging technologies for assessing populations, as described below and in Appendix A.

- *Water quality*: NFWF collects project-level metrics on BMP implementation as well as nutrient, sediment, and stormwater reductions associated with individual projects.
- *Eastern brook trout*: NFWF will collaborate with implementing partners and state agencies who manage trout resources (NY, NJ, PA) to measure baseline EBT relative abundance where significant restoration investments will be made. Temporal surveys of EBT within high value patches within focal areas EBT population patches must meet the portfolio criteria for **stronghold** (i.e., having sufficiently large populations and intact habitats to facilitate recovery from rapid environmental change) or **persistent** (i.e., saving enough different populations so that some can be lost without jeopardizing the species).
- *Alosine species*: NFWF will invest in monitoring within priority rivers where existing monitoring is not already in place. To assess fish presence above rectified dams, electrofishing or other comparable methods will be used to confirm the presence of American shad, blueback, and/or alewife within the

sampling period (spring to early fall) to evaluate trends in habitat use before and after restoration efforts.

Forest Habitat. Bird monitoring will build upon existing monitoring within blocks of contiguous forest of at least 5,000 acres. The science behind forest block size is grounded in habitat use of indicator species during the post-fledging period. After leaving the nest, parents and dependent young require more habitat—for golden-winged warbler (a young forest indicator) fledglings range up to 700m from nest at 30 days, suggesting a minimum patch size of 400 acres. In contrast, wood thrush (a mature forest indicator) will travel up to 1,500m from nest at 30 days, suggesting a minimum forest block of 1,800 acres. Lastly, cerulean warblers (a late successional forest species) can travel more than 2.5km from the nest at 30 days, suggesting a minimum forest block of 5,000 acres. With the overall integrated forest management approach, the diversity of the forest structure and bird diversity will be assessed by establishing bird abundance, density, and occupancy baseline estimates in pre-treatment forest blocks and control blocks using point count sampling, and passive acoustic recording units. Monitoring forest management goals (acres per habitat type) can be tracked with land cover data and forest stand maps.

Table 6. Business plan metrics for species outcomes.

Species	Outcome	Metrics	Baseline (2017)	Goal (2027)
Coastal Habitat				
Red knot	Maintain the population of red knot using Delaware Bay during spring migration	# red knot estimated through direct counts	21,128 individuals	≥ baseline
	More than 50% of red knot maintain or exceed 180 grams optimal threshold weight	% red knot at >180g pre-departure body weight	40%	50%
	Provide high-quality horseshoe crab (HSC) spawning habitat in Delaware Bay	# of HSC eggs/sq/m	7,500	50,000
Saltmarsh sparrow	Maintain or increase density by restoring high priority salt marsh patches	# individuals/acre	Varies by site (See App. A)	≥ baseline
Stream and Riparian Habitat				
Eastern brook trout	Increase relative abundance in 5 patches	# of patches with increased brook trout	0	5
	Maintain populations by improving habitat and protecting high-quality habitat	# of patches with improved or protected habitat	0	2
Alosine species	Ensure priority streams are occupied by alosine species by improving aquatic habitat connectivity	# stream miles occupied by American shad	0	205
		# stream miles occupied by river herring	0	200
Forest Habitat				
Golden-winged warbler	Manage 18,000 acres of ESF forest habitat (at 3.6 territories per 25 acres) to support 300 breeding territories	# of breeding territories	Varies by site	300
Wood thrush	Manage 18,000 acres of mature forest habitat (at 3.9 territories per 25 acres) to support 1,400 breeding territories	# of breeding territories	Varies by site	1,400
Cerulean warbler	Manage 18,000 acres of late successional forest habitat (at 6 territories per 25 acres) to support 1,600 breeding territories	# of breeding territories	Varies by site	1,600

Budget

The following budget shows the estimated costs to implement the business plan activities (Table 7). NFWF will have to raise funds to meet these costs; therefore, this budget reflects NFWF's anticipated engagement over the business plan period of performance and is *not* an annual or even cumulative commitment by NFWF to invest. This budget assumes that current activities funded by others will, at a minimum, continue.

Table 7. Budget for Delaware River Watershed Business Plan.

BUDGET CATEGORY	Yrs 1-5 ($)	Yrs 6-10 ($)	Total ($)
Strategy 1. Restoration and Management of Nearshore Habitat			
1.1 Increase high-quality beach habitat at priority roosting and foraging sites	2,700,000	3,360,000	6,060,000
1.2 Reduce impacts of human and wildlife disturbances to critical red knot habitat areas	100,000	330,000	430,000
1.3 Research and monitoring shorebird success	300,000	550,000	850,000
1.4 Identify priority sites for the construction of living shorelines	180,000	0	180,000
1.5 Monitoring to evaluate salt marsh restoration success	400,000	600,000	1,000,000
1.6 Improve and increase high-quality salt marsh through habitat restoration and protection	1,000,000	4,600,000	5,600,000
Strategy 2. Restoration and Management of Aquatic Habitat			
2.1 Reduce the impact of polluted runoff on water quality and stream hydrology	4,720,000	4,800,000	9,520,000
2.2 Increase partner capacity through technical assistance and engagement	500,000	550,000	1,050,000
2.3 Restore connectivity in streams that support eastern brook trout	1,500,000	1,800,000	3,300,000
2.4 See 2.1	---	---	---
2.5 Identify and protect high-quality native trout patches	1,000,000	825,000	1,825,000
2.6 Establish robust monitoring for eastern brook trout	0	440,000	440,000
2.7 Identify priority sites for restoration of alosines	200,000	0	200,000
2.8 Establish and/or improve monitoring programs for alosines	0	330,000	330,000
2.9 Restore access to spawning habitat by increasing connectivity	1,500,000	1,800,000	3,300,000
2.10 Community outreach and education about alosines	0	275,000	275,000
Strategy 3. Management of Forest Habitat			
3.1 Develop forest plans and implement forest management for diverse forest structure and age classes	1,000,000	1,100,000	2,100,000
3.2, 3.3, and 3.4: See 3.1	---	---	---
3.5 Monitor within the established forest block(s)	200,000	600,000	800,000
Other			
Program assessment or evaluation	0	250,000	250,000
TOTAL BUDGET	**$15,300,000**	**$22,210,000**	**$37,510,000**

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Appendix A. Species Geographies & Monitoring

Focal Geographies

Program investments will be directed to key locations within the Delaware River watershed (Figures 5, 6 and 7). Below, Table 8 briefly summarizes the focal geographies by priority habitat and focal species.

Table 8. Focal geographies by habitat and species

Habitat/Species	Focal Geographies
Nearshore: Red knot and saltmarsh sparrow	1. Delaware Bay, areas of moderate to high overlap of red knot occupancy with horseshoe crab spawning beaches that coincide with high to very high coastal vulnerability index[6]. Sites include Reed's, Stone, Fortescue and Thompson's Beaches (NJ) and Millespione Beach in DE, denoted by the red line along the Bay shore (Figure 5). Priority patches for saltmarsh sparrow habitat restoration will follow *priority* and *honorable mention* marshes identified by the Atlantic Coast Joint Venture (ACJV) and partners[7].
Aquatic: Water quality	2. Eight targeted watersheds identified by the Delaware River Water Initiative as areas with highest potential to show impact to water quality in response to restoration and protection include: Kirkwood-Cohansey (NJ), Brandywine-Christina (PA/DE), Upstream Suburban Philadelphia (PA), Schuylkill Highlands (PA), Middle Schuylkill (PA), New Jersey Highlands (NJ), Upper Lehigh (PA), Poconos – Kittatinny (PA/NJ/NY). These areas are shown in gray thatch (Figure 6).
Aquatic: Eastern brook trout	3. Eastern brook trout patches contribute to a portfolio of Eastern Brook Trout populations in the Delaware River watershed. High-value patches are defined by an EBTJV and TU effort. Focal areas, shown in blue (Figure 6), are areas that contain high-value patches where restoration activities will be targeted to increase or maintain relative abundance of eastern brook trout. Focal areas are select watersheds in the Middle Delaware, Schuylkill, and Brandywine-Christina.
Aquatic: Alosine species	4. Four priority rivers throughout the Delaware River watershed (Figure 6) including: the Brandywine Creek (DE), the Paulins Kill and Pequest Rivers (NJ), and the Bushkill Creek (PA). Additional rivers will be prioritized for site assessment and planning projects, including the Schuylkill River (PA); Neshaminy Creek (PA); and the White Clay and Red Clay Creeks (DE).
Forests: Golden-winged warbler, wood thrush, cerulean warbler	5. Appalachian region, northern tier of the Delaware River watershed and primarily focused in NY, northeastern PA, and areas of northwestern NJ, and shown in pink where habitat for all three forest bird species overlaps (Figure 7). Designated areas include 5,000-acre forest block(s) and priority habitat for the forest bird species is based on the overlap of moderate, high, and very high priority habitat for each of the individual species habitat models.

[6] Coastal Vulnerability Index is a commonly used method to assess coastal vulnerability to sea level rise, in particular due to erosion and/or inundation (Gornitz et al. 1991).
[7] Saltmarsh Restoration Priorities for Saltmarsh Sparrow: https://experience.arcgis.com/experience/0a580f98787f4250bff871892d266d64

Species Monitoring

Additional detail on the business plan's focal species monitoring approach and/or site-based goals is provided below. In addition, NFWF may conduct an internal assessment or commission a third-party evaluation at a future stage of the business plan to determine outcomes and adaptively manage. In some cases, these course corrections may warrant increased investment; however, it is also possible that NFWF would reduce or eliminate support if periodic evaluation indicates that further investments are unlikely to achieve intended outcomes.

Red Knot

Several metrics are collected annually in support of monitoring the recovery and condition of red knot populations in Delaware Bay. To estimate the number of individuals using the Bay during spring migration, three or more aerial and/or ground count surveys are conducted during peak shorebird abundance (May 18 to May 30). Cannon nets are used to capture red knots and other shorebirds every 3-5 days to monitor weight change. All shorebirds are weighed, measured, and marked with leg bands and individually marked plastic leg flag bands. Repeat capture of individuals at the stopover provides an estimate of the number of individuals that reach the threshold weight of 180 grams. Red knot weights are statistically linked to horseshoe crab surface egg density (eggs/m2) and sufficient weight gain in Delaware Bay is linked to adult survival (Baker et al. 1994) and Arctic productivity (Duijns et al. 2017). Horseshoe crab monitoring (shallow egg abundance) is conducted annually to provide an index of spawning activity and shorebird food availability. Weekly counts of horseshoe crab eggs in the top 5cm of sand are used to generate an index of horseshoe crab spawning cohort strength each year.

Saltmarsh Sparrow

The business plan aims to restore 1,500 acres of priority salt marsh habitat across the Delaware Bay by 2027. The Atlantic Coast Joint Venture (ACJV), in consultation with states and other partners, have identified high priority and honorable mention marshes where restoration or protection activities will support saltmarsh sparrows. Regionwide breeding surveys were completed from 2011 to 2012 and were used to develop Bayesian network models to estimate patch-scale saltmarsh sparrow density (Wiest et al. 2019). The ACJV estimates the saltmarsh sparrow population is currently declining at a rate of 9% per year. To develop patch-level density estimates for this business plan (Table 9), the 2011/12 data were multiplied by a 9% annual decline rate to develop projected 2022 baseline estimates for the plan. As patches are restored through implementation of business plan strategies, patch-level monitoring will allow NFWF to track saltmarsh sparrow response to restoration and relative to the projected 2022 baseline estimates. Once available, data from ongoing 2021/2022 range wide surveys will be used to update density estimates as needed.

Eastern Brook Trout

The business plan will employ a full suite of restoration activities to improve the patch status (e.g., from persistent to stronghold) of five high quality patches. Patch improvement is hypothesized to result in increased relative abundance, which will be monitored within the five high value patches in focal areas. Monitoring and sampling will be designed at the appropriate scale to measure a difference in relative abundance across each patch. Relative abundance measures can include catch per unit effort or biomass. Traditional and standard fisheries sampling methodologies will be used. These include, but are not limited to, fishing gear, proper distance upstream/downstream from restoration sites within a patch, environmental data, and effort data. Pre- and post-restoration grantee monitoring that meets the standard monitoring scheme will be used when possible. Grantee monitoring will be supplemented with NFWF contractor monitoring where needed.

Alosine Species (American Shad and River Herring)

To assess habitat use and occupancy, NFWF will evaluate trends in the occurrence and extent of spawning adults, before and after restoration efforts within focal rivers. Monitoring will confirm presence of fish below rectified dams prior to restoration and assess potential habitat use above the barrier once rectified using standard methodologies such as electrofishing, juvenile seine surveys, or other comparable methods. Where possible, additional monitoring will assess adult spawning runs at fixed monitoring locations to estimate any increases in American shad and river herring populations within focal rivers. NFWF will also track the number of barriers with completed site assessments, engineering and design plans as well as the number of dams rectified through removal or improved fish passage via fishways. The number of stream miles opened will also be calculated by quantifying the upstream functional network above rectified dams following the methods described in the Northeast Aquatic Connectivity Assessment Project 2.0 (Martin & Levine, 2017). In this business plan, upstream functional network is defined as the number of miles upstream of a barrier to the next upstream barrier. The estimates should include stream reaches that may potentially be accessible to alosines once a barrier is rectified.

Forest Birds

The business plan aims to improve forest management in the upper Delaware River watershed through development of Dynamic Forest Restoration Block (DFRB) plans to guide implementation of diverse forest age classes. Forest management activities will focus on balancing the age class distribution and improving stand structural conditions via stand improvements (i.e., invasive control and low shade removal), non-commercial actions (i.e., mechanical and prescribed fire), and extending the forest rotation age (200-500yrs) to allow additional stands to advance into late seral stage forest (>125 years). Establishing and maintaining early successional and structurally complex mature forest stands will also be critical to our ability to meet the full-breeding season needs of priority bird species. NFWF will track acres planned and acres implemented. Bird response to forest management will be monitored through point counts and use of passive acoustic recording units (ARUs) to estimate target species occupancy and abundance changes by collecting pre-management baseline data and post-treatment bird data. Within each DFRB, a suite of stratified random points will be generated, each >250m apart to avoid double counting individual birds. Points will be sampled for bird presence following standard point count protocols twice annually and in conjunction with ARUs to generate estimates of the number of territorial pairs for each of the three focal species in the plan.

Table 9. Saltmarsh Sparrow Density Estimates within Priority Marshes

Patch Name	ACJV Category[8]	Patch Size *(acres)*	2011/2012 Density *(birds/acre)*	Projected 2022 Baseline Density[9] *(birds/acre)*
Delaware Marshes				
Broadkill ("Great Marsh") and Unit IV of Prime Hook NWR	Priority	4,355	0.026	0.010
Milford Neck and Mispillion River	Priority	5,921	0.000	0.000
Steamboat Tract (Bombay NWR) and Port Mahon	Priority	4,615	0.054	0.021
Prime Hook	Priority	3,944	0.026	0.010
Little Creek	Honorable Mention	1,419	0.054	0.021
St. Jones	Honorable Mention	2,681	0.054	0.021
New Jersey Marshes				
Dennis Creek	Priority	5,547	0.000	0.000
Fortescue	Priority	3,773	0.035	0.014
Maurice River / Heislerville WMA	Priority	1,936	0.000	0.000
Back Creek	Priority	4,601	0.035	0.014
Dividing Creek/Garrison	Priority	4,753	0.035	0.014
Mad Horse Creek WMA to Cohansey	Honorable Mention	13,466	0.026	0.010
Gandy's Beach	Honorable Mention	349	0.035	0.014
Green Creek	Honorable Mention	349	0.000	0.000
Reeds Beach	Honorable Mention	1,290	0.000	0.000
Egg Island WMA	Honorable Mention	703	0.035	0.014
Higbee Beach	Honorable Mention	326	0.201	0.078

[8] Atlantic Coast Joint Venture categorizes marshes into priority and honorable mentions (see https://experience.arcgis.com/experience/0a580f98787f4250bff871892d266d64)

[9] Projected 2022 density estimates apply a 9% annual decline rate to 2011/2012 density estimates. As data from ongoing 2021/2022 rangewide surveys become available density estimates will be updated as needed.

Appendix B. Carbon Co-Benefits

Although NFWF business plans are aimed at achieving habitat and species goals, NFWF is committed to understanding the broader impacts of these investments in conservation. Specifically, NFWF has begun measuring other environmental and social co-benefits from business plan investments, including carbon benefits.

NFWF estimates the activities funded through the life of this business plan will yield a 30-year carbon benefit, either sequestered (i.e., removed from the atmosphere) or through avoided emissions, of between 1,689,000 to 2,533,000 metric tons CO_2 equivalent. NFWF produced this estimate using open-source datasets, various scientific reports, and IPCC guidelines. NFWF estimates the carbon benefit not to claim any formal carbon credits, but rather to demonstrate the co-benefits that accrue from our business plan's conservation investments for fish, wildlife, and habitats.