8

Restoration

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Chapter 8 – Restoration

Introduction

The objective of this section is to provide information on restoration efforts and progress in the Delaware Estuary. Whereas Chapters 1 to 7 review the status and trends of environmental indicators, this chapter is a first attempt to gauge the success of our collective efforts to *improve* environmental conditions via management actions that protect, enhance, and restore the system. To date, no entity has quantified the cumulative management and restoration progress across the basin. The indicators presented in this chapter should therefore be regarded as baseline measures to be strengthened in future expanded assessments of management progress. Restoration data from multiple states and programs are challenging to collect and analyze, and for this pilot attempt the indicator analyses are based on limited project tracking data routinely collected for the National Estuary Program and which were available at the time of this report. Future efforts to assess management and restoration progress are expected to be enhanced with the advent and implementation of new tracking tools being developed at the Partnership for the Delaware Estuary (PDE), some of which are discussed in this chapter.

The term restoration can be thought of in several ways. Ecological restoration indicates that degraded and destroyed natural systems will be reestablished to sites where they once existed. Restorationists have considered this at length and addressed them in the current definitions of restoration and restoration-type activities. A simple and useful definition of restoration was developed by the National Research Council (NRC). In its 1992 report, *Restoration of Aquatic Ecosystems*, NRC defined restoration as the "return of an ecosystem to a close approximation of its condition prior to disturbance." Also, the Society of Ecological Restoration defines ecological restoration as the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.

The concept of restoration is further clarified by defining many types of restoration-related activities. There are many "non-point" management actions that can be considered as restoration activities, such as land and habitat protection, flow management and pollutant regulation. However, for our purposes here "restoration" is used to mean on-the-ground actions that create, enhance, or restore natural resources. In the future with better data, management progress should be broadened to include any actions or decisions that lead to improvements in environmental conditions as assessed by the indicators in Chapters 1-7, such as by the elimination or reduction of stressors that degrade natural conditions. In addition to traditional restoration of past natural conditions, the following terms describe activities that are considered as part of restoration for the purposes of this chapter.

Fig. 8.1. Example of reestablishing a riparian buffer along a tributary in the Delaware Estuary

Establishment (also referred to as "creation") is the manipulation of physical, chemical, or biological conditions to facilitate development of a target habitat that is representative of natural conditions but that did not previously exist at the project location. Establishment results in a gain in acres for the target habitat. For example, establishment occurs when a wetland is placed on the landscape by some human activity on a non-wetland site (Lewis, 1989). Typically, a wetland is created by excavation of upland soils to elevations that will support the growth of wetland species through the establishment of an appropriate hydrology.

Reestablishment is the manipulation of physical, chemical, or biological characteristics of a site with the goal of returning natural/historic habitat types and functions to the site. Reestablishment results in the rebuilding of a former habitat and a gain in acres for that target habitat.

Enhancement is the manipulation of physical, chemical or biological characteristics of a site to strengthen ecological conditions and functions, such as for the purpose of improving water quality, flood water retention, or wildlife habitat. Enhancement typically results in improvement of structure and/or function without an increase in acreage.

Rehabilitation is similar to enhancement and is defined by the EPA as the manipulation of the physical, chemical or biological characteristics of a site with the goal of repairing natural/historic functions of a degraded habitat. Rehabilitation results in a gain of habitat function but does not result in a gain of acres for that habitat.

USDA-NRCS-NJ

Fig. 8.2. Example of enhancement: Streambank erosion on Walnut Brook. Left April 2007, Right August 2009

In all types of restoration, changes in ecosystem conditions should result in a net gain or improvement in those targeted natural goods and services that are deemed of highest value by managers. Since the environmental conditions at any location never have zero value, scientists and managers must recognize that any manipulation results in tradeoffs in habitats, living resources and functions. Efforts to control mosquito populations and improve fish habitat by digging ditches in wetlands could result in decreased vegetation cover and carbon sequestration services. Restoration activities therefore ultimately reflect value judgments that can differ among different sectors of the scientific and management community. Our goal is to quantify restoration progress that reflects the current consensus view on ecological priorities, focusing on key natural resources that typify the Delaware Estuary and River Basin.

Activities that might be considered restoration progress but which do not necessarily fit the definition of restoration given on the previous page include the following:

Protection is defined as the removal of a threat to, or preventing the decline of, natural healthy environmental conditions. This includes management actions such as land acquisition, conservation easements, deed restrictions, etc. or other designations to prevent alteration of natural site conditions. This term also includes activities commonly associated with the term "preservation". Although protection efforts are critically important for sustaining natural goods and services, they do not result in a net gain of hectares or habitat function relative to past conditions

Mitigation refers to the "restoration, creation, or enhancement of wetlands to compensate for permitted wetland losses" (Lewis, 1989). Here, we also extend that definition to include other natural habitats. For example, under Section 404 of the Clean Water Act, wetlands may be legally destroyed, but their loss must be compensated by the restoration, creation, or enhancement of other wetlands. In theory, this strategy should result in "no net loss" of wetlands. Other programs that are similar include the Natural Resource Damage Assessment (NRDA) Process and Supplemental Environmental Projects (SEPs). Whether mitigation is successful or not, the goal is to simply replace or repair injured natural resources, meaning that these activities do not (and in some cases legally cannot) result in net gain in habitat acreage or functions relative to pre-injury conditions.

The approach taken in this chapter was to develop new indicators that reflect restoration activities across the Delaware Estuary and Basin, focusing on metrics that can be quantified such as hectares, locations, and types of habitats restored and available data. It's important to note that in contrast to these restoration activities, many important habitats are continuing to be lost or degraded (see other chapters).

1 – Hectares Restored Annually

1.1 Description of Indicator

Many important resources are found in the Delaware Estuary and Basin. For example, the estuary contains more than 163,897 hectares of wetlands, more than 50,990 of which are recognized as internationally important (PDE 2006). The tidal portion of the system is also one of the largest freshwater tidal estuaries in the world, and despite losing >95% of rare freshwater tidal wetlands the system still has more hectares of this habitat type than anywhere else in the United States. The Delaware Estuary also has 185 natural vegetation community types encompassing 35 broader-scale ecological systems. Delaware Bay contains the largest breeding population of horseshoe crabs in the world. The watershed also contains critical habitat for endangered populations of dwarf wedgemussels, two species of sturgeon, and bog turtles.

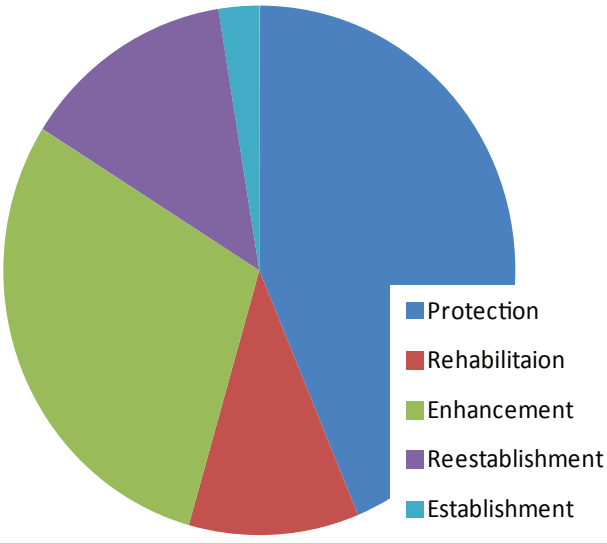

Fig. 8.3. Comparison of the land area protected versus restored by between 2000 and 2011, as reported in NEPORT

Considering the tremendous habitat diversity, numerous geopolitical boundaries, and large size of the watershed, efforts to track restoration progress are hampered by limited data availability among the many different agencies and programs that are responsible for restoration. One of the most straightforward ways to track habitat restoration is to determine hectares restored annually, focusing on voluntary actions (and not reparative, regulatory based actions such as mitigation projects). However, tracking the loss of habitat is also helpful to put restoration into context. Ideally, restoration activities should also be assessed for specific habitat types. In the future, it would be beneficial to also assess the functionality of restored habitats, since a particular site could be "restored" significantly without any net increase in acreage. However, at present, finding information about all of these activities is difficult. For this pilot effort, we relied on acreage data that has been reported as restored (and also protected) by each state (New Jersey, Pennsylvania, and Delaware) annually using the EPA's National Estuary Online Reporting Tool (NEPORT).

NEPORT is a web-based database that EPA has developed for National Estuary Programs (NEPs) to track annual acreage of habitat improvement efforts. This is a part of the goals of the 1996 Comprehensive Conservation and Management Plan (CCMP) for the Delaware Estuary. The Partnership for the Delaware Estuary has been collecting data on completed restoration projects from partners (mainly state agencies and PDE initiated projects) since 2000 to report to the EPA each year. The EPA then provides the project information for every National Estuary Program on this website: http://www.epa.gov/owow_keep/estuaries/pivot/mapping/sat.htm .

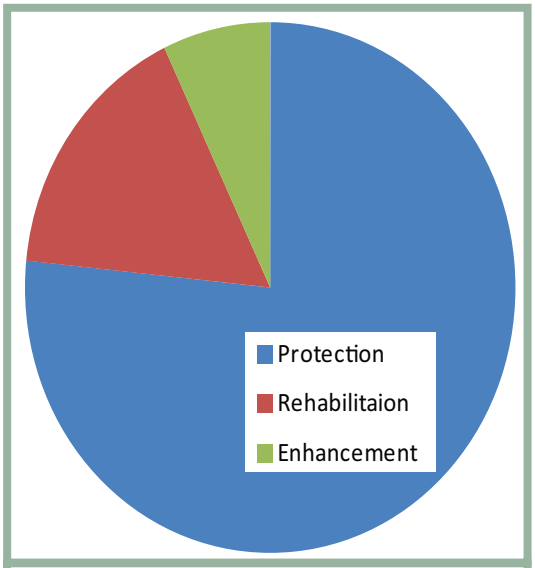

Fig. 8.4. Comparison of land area protected versus restored in 2011 as reported in NEPORT

Unfortunately, there is no coordinated tracking system at this time to determine how many *net* hectares have been restored or gained/lost in the watershed, and NEPORT is not comprehensive due to it only showing project data that has been voluntarily provided from partners of the Partnership for the Delaware Estuary. These data therefore represent only a fraction of restoration progress at the watershed scale. Since a similar approach has been followed for more than ten years it is possible to examine trends in restoration progress using NEPORT data alone as an indicator. However, it should be noted that EPA does occasionally make changes from time to time on how NEPORT data is reported. Another advantage of NEPORT data is that the tracking program excludes actions associated with mitigation (e.g. NRDA, SEP), which are designed simply to correct for discrete injuries. Although protection efforts are not the focus of this chapter (see above), NEPORT data for protected acreage are also shown here for comparison purposes.

1.2 Present Status

Since quantitative data on the number of hectares restored is best considered temporary (see trends, Section 1.3), the present status was examined qualitatively by contrasting the types of restoration progress made in the Delaware Estuary according to NEPORT. NEPORT tracks restoration as: protection, rehabilitation, enhancement, reestablishment, or establishment. The relative balance of these activities for the entire reporting period is 2000-2011 (Fig. 8.3) and indicates that considerably more land area has been protected than restored. Among the four types of restoration tracked in NEPORT, more area was enhanced than rehabilitated or reestablished, and newly created acres (establishment) represented a very small portion of overall efforts.

As noted above, protection does not improve ecological conditions. Therefore, summing acreage data from NEPORT does not give a clear representation of actual net ecological improvement since so much of what is reported took the form of protection (Fig. 8.3). This finding is even more important for the most recent NEPORT data from 2011 (Fig. 8.4), which shows that protection accounted for more than three-quarters of total proportional activity types.

1.3 Past Trends

As a National Estuary Program, the Partnership for the Delaware Estuary is responsible for setting restoration goals (including protection) every year, and since the advent of NEPORT tracking in 2000 this annual goal has been about 1012 hectares. As noted above, tracking restoration is challenging because PDE must rely on voluntary reporting by partners. Year to year variation in restoration investment also tends to vary greatly because projects are typically grant-funded and thus subject to funding fluctuations. Despite these caveats, restoration progress since 2000 has been considerable (Fig. 8.5). The annual progress is shown in Fig. 8.5 in comparison to the annual target of 1,012 hectares for the combination of protection and restoration. This target was met in eight of twelve years, and the overall amount of area protected or restored for the twelve-year period was 26,658 hectares. (Reported by Pennsylvania, Delaware, and New Jersey, City of Philadelphia and projects funded through the National Fish and Wildlife Foundations Delaware Estuary Watershed Grants Program to the Partnership). In most years since 2000, protection efforts surpassed restoration efforts, largely due to data reporting from programs such as New Jersey Green Acres that provides funding for land acquisition.

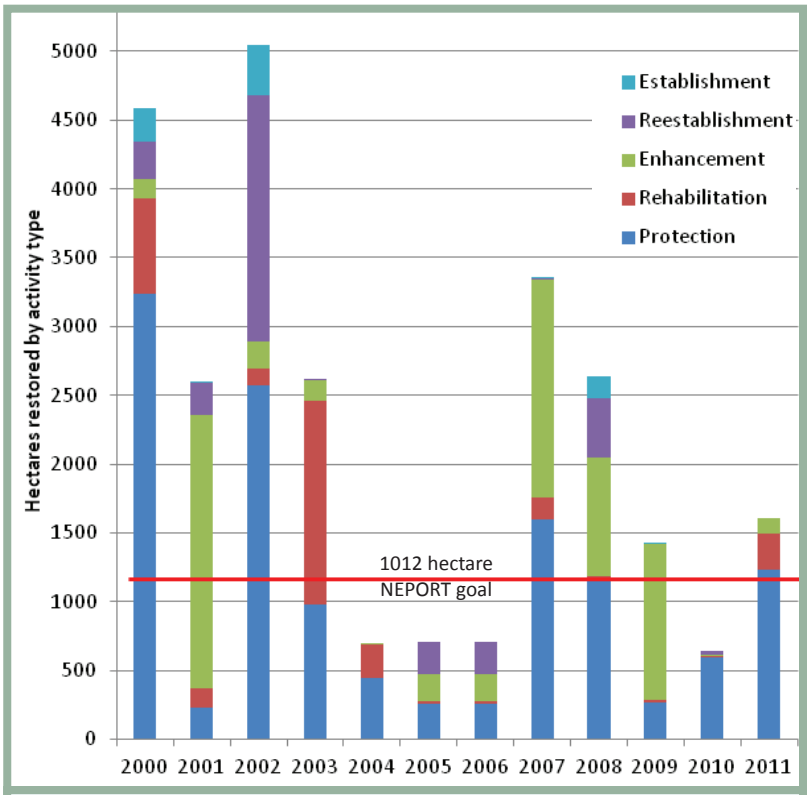

Fig. 8.5. Hectares restored and protected annually between 2000 and 2011, with four types of restoration reported separately, in relation to the annual NEPORT goal set by the Partnership for the Delaware Estuary

1.4 Future Predictions

The amount of area restored per year in the Delaware Estuary (per NEPORT) through non-mitigation, voluntary actions is dependent on funding, especially from state and federal agencies. The restoration need is high (as judged by the continuing losses of critical habitats, see Section 1.5) and funding for restoration is limited. However, we are optimistic that in the long term the pace of restoration will hasten as our understanding of the ecological and economic consequences of inaction increases. In the short-term, we anticipate that the recent trend in restoration investment will be sustained and that the Estuary Program will continue to meet the annual 1012 hectare goal. This progress could be undermined with continued reductions in funding, especially for open space protection.

1.5 Actions and Needs

Unfortunately, hundreds of thousands of hectares of natural habitats have been destroyed or significantly altered in the Delaware Estuary watershed during the past 10-15 years despite many governmental protections (see other chapters). Losses of forest area due to development (Chapter 1) and erosion of coastal wetlands (Chapter 5b) appear to far exceed any gains from restoration. Since these natural habitats purify our water, provide clean air to breathe and furnish other critical goods and services enabling the survival of both humans and natural communities, this trend in net loss of natural habitats is unsustainable, especially considering projections for human population growth (chapter 1). The Comprehensive Conservation Management Plan (CCMP) requires that restoration, protection and enhancement of natural habitats be a primary program objective of the Partnership for the Delaware Estuary, and a critical need will be to sustain funding for implementation of the CCMP as well as other core management programs that seek to reverse the declines in natural capital for the region, and to boost investment in voluntary restoration and protection of our remaining natural habitats.

Considering the limited restoration funding and high need, careful prioritization will be essential so that projects that get implemented target the most critical needs for maintaining core estuarine functions (PDE 2005, 2007, Kreeger et al. 2006). The Delaware Estuary Regional Restoration Initiative (RRI) is an example of a prioritization program that seeks to identify the most ecologically significant species and habitats in a geospatial framework and then to direct restoration efforts to pivotal places and activities that lead to the greatest "uplift" of these resources. Ecologically significant is a designation given to natural resources which supply critical ecosystem goods and services, such as by a functional dominant species or habitats (or if they are rare then they must be threatened or a hallmark feature of the watershed). The RRI also intends to build efficient collaborations to spatially map and track restoration actions and build science-based consensus on restoration priorities.

Future monitoring and assessment reports would also be strengthened by development of enhanced tracking tools for restoration data, enabling better comparisons with land use data on habitat losses such as associated with development. One example of how tracking data can be used to inform habitat prioritization from the Schuylkill Watershed is a project by the Schuylkill Action Network and Delaware Valley Regional Planning Commission (DVRPC). The Schuylkill Watershed Priority Lands Strategy uses GIS modeling to identify areas within the Schuylkill Watershed that are the most important to preserve for both ecological and drinking water source protection, further defined by development threat over the next 20 years. Because developed land in the Schuylkill Watershed is expected to increase by 40% over the next two decades, this strategy can be used to direct inappropriate uses away from high priority resource areas as well as a guide to where restoration efforts can be most effective. The model is a series of maps that can be viewed on-line at http://www.schuylkillprioritylands.org/index.html. DVRPC has used this model to set goals for protection. See also Chapter 1, section 3.5, for actions and needs regarding land protection based changes in land cover trends.

1.6 Summary

Quantitative measures of land area restored annually in the Delaware Estuary can be an effective way to track management progress, and analysis of limited data suggests that some progress has been made since 2000. However, the current tracking system used by the Partnership for the Delaware Estuary (NEPORT) is not designed to be comprehensive for the watershed, and it gives a biased estimate of the amount and type of restoration in the estuary because of the limited voluntarily-contributed data that it is based on. It is useful as a progress indicator because annual data collection has been consistent for a sufficient period to examine trends, showing that some management targets set by the National Estuary Program have been met. Improvements in such reporting would be to strengthen future status and trends reporting on management progress. Although NEPORT data significantly underestimates actual restoration investment across the entire Delaware Estuary and Basin, the amount of land area restored between 2000-2011 was certainly dwarfed by mounting losses of natural lands due to development and other factors, as demonstrated by land use land cover changes described in Chapter 1. This clearly suggesting that management progress via restoration is not keeping pace with overall needs to sustain core habitats.

2 – Balance of Restoration Project Types

Introduction

In addition to the assessing the amount of area restored, it is helpful to track the types of habitat that are being restored to ensure that restoration progress reflects the balance of habitats that have suffered the most degradation and/or are currently being lost most rapidly. For example, coastal wetlands are a hallmark feature of the Delaware

Estuary, are critical for supplying diverse benefits to people and the environment, and we have lost more than half of our coastal wetlands mainly because of direct filling and development (Chapter 5b). Deciduous forests are similarly vital for sustaining source water quality and other services, and forest losses continue to be swift due to development (Chapter 1). Has restoration (and protection) investment over the past decade targeted these (and other) crucial habitats that are in decline? Similar to Section 8.1, data from the National Estuary Program Online Reporting Tool (NEPORT) was examined to discern what types of habitats have generated the greatest restoration attention since 2001.

2.1 Description of Indicator

Healthy estuaries depend on a complex mix of habitats, and every estuary has its unique character and habitat assemblage. Although the Delaware Estuary and Basin is home to dozens of different habitats and ecological communities, it is most distinct because of its abundant, protective forests in the headwaters, broad freshwater tidal area that supports rare biotic assemblages, and a wealth of coastal wetlands that fringe the tidal estuary. Hundreds of thousands of hectares of natural habitats have been destroyed or significantly altered in the Delaware Estuary watershed. These systems purify our water, provide clean air to breathe and furnish other critical goods and services enabling the survival of both people and natural communities. To get the greatest benefits, voluntary (non-mitigation) attempts to rebuild these habitats should reflect the natural balance of types that characterizes the watershed.

2.2 Present Status

Fig. 8.6 shows a comparison of all the hectares restored between 2000 and 2011 by habitat type. Tidal wetland and forests have been the focus of management attention since 2001, judging from the combined data for protected and restored habitat types (Fig. 8.6). Most of this was via protection (see Section 8.1) and efforts to protect and restore tidal wetlands represented the greatest progress.

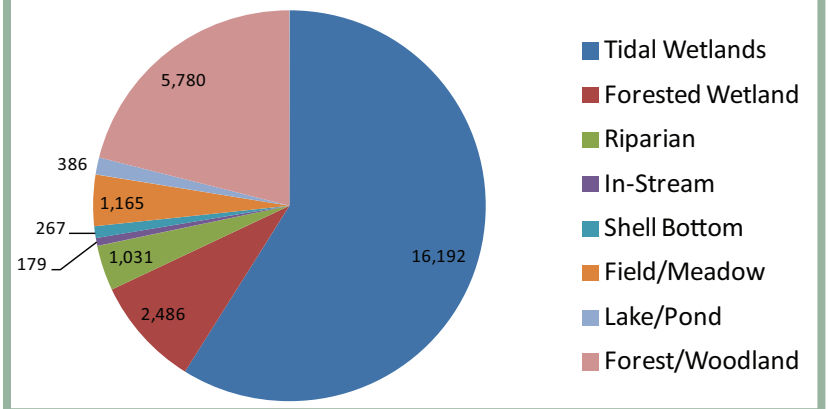

Fig. 8.6. Comparison of hectares restored by habitat type between 2000 and 2011 as reported in NEPORT

In general, the relative balance of protection and restoration progress compared among habitat types does therefore match the types of habitats that have been experiencing the greatest losses, tidal wetlands and forests. As noted in Chapter 5b, it is believed that more than half of our tidal wetlands have been lost in the Delaware Estuary compared to pre-settlement acreage, acreage losses between 1996 and 2006 exceeded 2%, and future projections suggest that a minimum of 50,000 more hectares will be lost by 2100 with a sea level rise of one meter. Forests continue to be lost at an even faster clip, and the cumulative impacts from natural gas drilling and other contemporary challenges threaten to hastenloss rates in the upper basin. In the future, continued focus on tidal wetlands and forests is therefore warranted. Some other habitats that have been prioritized such as bivalve shell reefs are arguably even more vital, but they are also smaller in size and harder to capture in terms of hectares.

2.3 Past Trends

The amount of area protected and restored varies widely among years and among habitat types (Fig. 8.7). There is considerable variability among years and habitats due mainly to fluctuations in available funding from year to year, as well as shifts in reporting from various state and local partners who report data to NEPORT. Although it is difficult to draw any conclusions from these limited data, there is an apparent downward trend in the total acreage restored and protected. There also appears to be an increase in the diversity of project types reported to NEPORT. It is possible that these differences simply reflect variability in reporting rather than real patterns.

2.4 Future Predictions

Several analysis and planning initiatives currently exist to prioritize protection and restoration activities at the watershed scale in the interests of targeting key species, habitat types, and places to more effectively increase not only the acreage restored but the overall health and functionality of the estuary's key ecosystems. For example, in November 2011, The Nature Conservancy and partners completed a set of protection and restoration strategies to conserve the Delaware River Basin from the headwaters to the Bay. Their prioritization report (TNC 2011) included various strategies to target high value places in the landscape for protection and restoration. Floodplains, shellfish populations, and habitat for migratory fish

were some of their focal resources.

PDE's Regional Restoration Initiative, introduced in 2009, similarly attempts to guide future decisions on restoration, protection and enhancement by focusing on habitat types and living resources that furnish key ecosystem goods and services, and identifies for places in the landscape where restoration action can yield the greatest return on investment. As part of the RRI, a technical workgroup (Regional Restoration Workgroup of the STAC) and a decision-maker group (PDE Alliance for Comprehensive Ecosystem Solutions) have been formed to help implement the regional restoration approach using an iterative, science-based approach. Current habitat priorities for the RRI are urban waterfronts, tidal wetlands, headwater streams, and bivalve shellfish. As part of this effort, an online Project Registry helps to identify and fund priority restoration activities, and as this registry further develops it is expected to also be useful for gathering data future indicator reports such as this. Both efforts hold great promise for increasing the quality and quantity of restoration in the Basin, but only to the extent that funding is available to do the work.

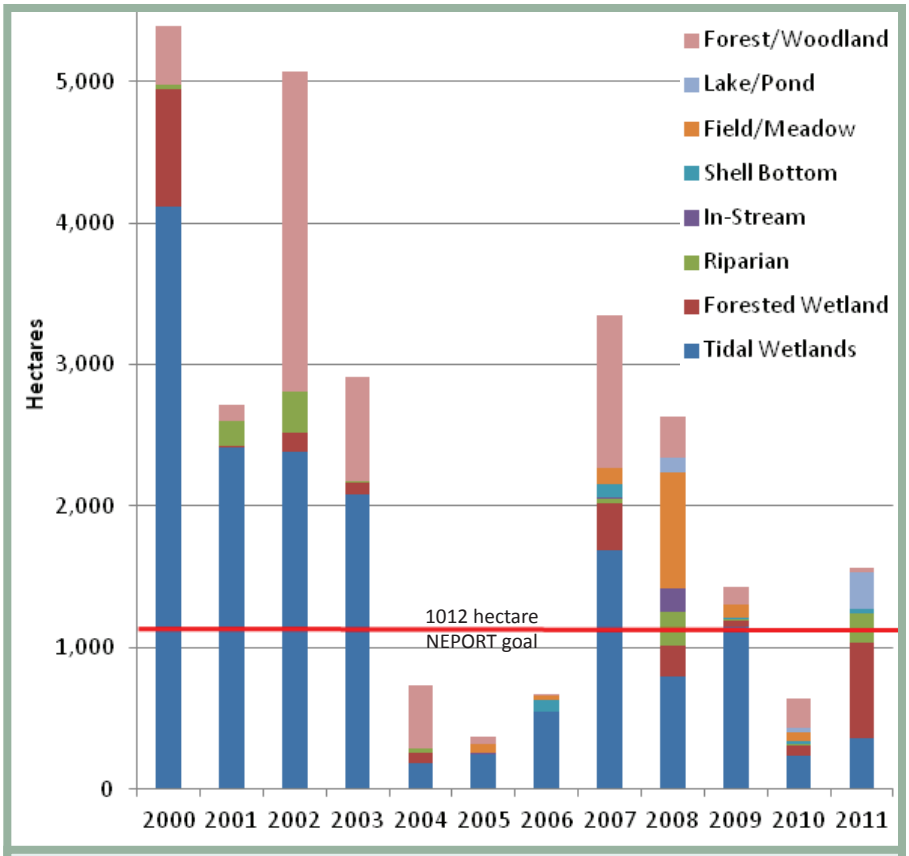

Fig. 8.7. Hectares restored annually by habitat type

2.5 Actions and Needs

In addition to setting overall goals for the amount of habitat to be restored, restoration investment should target habitat types that are deemed most critical for preserving the character and functionality of the unique Delaware Estuary watershed. New conservation and restoration prioritization tools that specify habitat types and places to be targeted should be used to guide strategic investments. To facilitate smarter restoration as well as progress tracking, data for completed projects should be entered into the PDE project Registry, along with data on unfunded project needs. Increased promotion, use, and maintenance of the PDE project registry could provide additional valuable information for continuing this effort in the future.

2.6 Summary

The balance of habitat types restored and protected in the past 12 years can be analyzed with data from the National Estuary Program Reporting Tool. Although results from this analysis should be interpreted with caution because the dataset is limited, restoration progress in the Delaware Estuary appears to be targeting the appropriate habitat types that are considered most vital and which are experiencing greatest losses.

3 – Restoration Need

Introduction

The need for more restoration in the Delaware Estuary and Basin is sizeable and plain to see judging from the disparity between the historic and recent losses in acreage of natural lands (see other chapters) and the relatively small gains in acreage from restoration efforts over the past decade (see Section 8.1). Although science-based planning tools have been recently developed to guide strategic restoration and protection investment at the watershed scale, these tools will be useless without funding to implement new projects to offset losses that go well beyond site-specific, regulatory-

based mitigation. In the future, PDE and partners intend to further clarify the restoration need by developing new metrics and indicators. In this section, we provide a foundation for this future effort by gathering limited data on our restoration need, contrasting this with the level of current investment, and comparing results to some other large American "Great Waters".

With the continuous loss of habitat from development and sea level rise and lack of funding for environmental conservation, strategic measures need to be taken to implement restoration actions aimed at reaching the maximum ecological function for priority habitats while using scarce resources wisely and developing future funding sources. PDE's Regional Restoration Initiative establishes the framework for a watershed-wide ecosystem based approach to management and restoration using some basic tools. There are a vast array of projects and actions that impact the restoration status of the estuary at a local, regional, and estuary/coastal stage, it is very challenging to catalogue and evaluate the cumulative effect of all these actions.

Better tools need to be developed to be able to track completed restoration projects throughout the estuary, to prioritize restoration and know restoration project gaps, and to monitor completed restoration projects to ensure that the ecosystem function is being restored and to gain knowledge in order to improve future restoration. A sustainable funding source will likely be required. However, progress has been made in ecosystem based approaches including an evaluation of the economic value of the Delaware Estuary (in terms of ecosystem services and economical benefits) by the University of Delaware. The report found that by using economic activity as a measure of value, the Delaware Estuary contributes over $10 billion in annual economic activity from recreation, water quality and supply, hunting and fishing, forests, agriculture and parks (Kauffman 2011). This information can be used to evaluate restoration actions and identify the ecological and economic benefits in addressing community needs.

The PDE Project Registry, part of the overall Delaware Estuary Regional Restoration Initiative, includes regional restoration needs in terms of submitted restoration projects and could serve as a clearinghouse for restoration projects across the watershed if well populated and maintained.

In addition to assessing restoration on a regional scale, restoration can also be assessed at a site, media, and or event level of scale. For instance, if a contaminated site or Brownfield property is cleaned up and/or restored, this is restoration at a local level. Often there is restoration of habitat as part of a cleanup and/or natural resource damage assessment. These types of projects, especially in a cumulative fashion, can support the restoration goals of the CCMP if the goals are considered and integrated. An example is ecological restoration of a shoreline area or tidal wetland as part of a removal or stabilization/ containment remedy. The Clean Water Act through its permitting and enforcement provisions can support restoration efforts related to increasing water quality and obtaining targeted water quality uses, as well as protecting wetlands and other aquatic habitats. Through this process there can be cumulative permitted losses of aquatic habitat and functions for which mitigation projects are required. The cumulative impacts of both losses and mitigation benefits need to be evaluated on a more comprehensive basis in order to evaluate the impact of regulatory programs on estuarine restoration goals.

3.1 Description of Indicator

One approach to assessing restoration needs is to examine the present status for other indicators in this technical report, relative to past conditions. As a whole, this information is useful for managers who must establish restoration goals since they can frame realistic or stretch goals better when they are grounded in tangible data on ecological trajectories of change. But for the exploratory purposes of developing restoration specific indicator of restoration need, we can simply tally the total dollars required to fund pending projects in the new Delaware Estuary Project Registry. The registry is less than three years old and new projects are being added continually as restoration practitioners and managers learn about the registry and its dual purposes (matching projects with funders, tracking needs and implementation); therefore, the total need is substantially underestimated by the Registry. However, with increased promotion and use over time, the usefulness of this as an indicator should improve.

3.2 Present and Past Status

Currently, the project registry contains 90 unfunded projects totaling over 60,000 hectares of possible restoration throughout the Delaware Estuary and Basin. The projects currently in the registry that need funding have requested budgets totaling more than $10,500,000. These projects represent only a fraction of total watershed needs to reverse net losses and achieve no net loss of natural lands. Even if completely funded and implemented, continued annual restoration investment would be needed beyond the initial investment because of mounting development pressures from human population growth and changing climate conditions (e.g. sea level rise). This estimate of restoration need is tremendous, especially considering the difficult current financial situation. However, it represents only about 1.5% of the annual worth of the natural resources of

the basin, which were recently valued as contributing over $10 billion in annual economic activity associated with recreation, water quality and supply, hunting and fishing, forests, agriculture and parks (Kauffman 2011).

The Delaware Estuary and Basin is also not unique, and other large American estuaries likely have similar needs. Another way to assess restoration progress is to look at how restoration investment here compares with investments in other large American "Great Waters". The Northeast-Midwest Institute recently reported (Strackbein and Dawson 2011) that the level of investment from one example federal agency, the US EPA, was considerably lower in the Delaware Estuary and Basin than eight of the other most significant aquatic systems that are managed discretely. This analysis suggests that federal environmental investment in the Delaware system is far less than 10%, perhaps even 1%, of that invested in the Chesapeake system (Fig. 8.8), despite having a similar human population.

Restoration investment can also be examined on a geospatial basin and contrasted with consensus views on restoration needs, using data from NEPORT (see Sections 8.1, 8.2), and this can then be compared with human population in those areas (Fig. 8.9).

Typically, restoration needs are higher in areas where human population is higher due to habitat degradation associated with pollution, development and other anthropogenic disturbances. Although most people live in the upper estuary region (Fig. 8.9), most protection and restoration progress between 2001 and 2011 has been made in other watershed regions (Fig. 8.10). For example, the Delaware Bay and Upper Estuary had more investment likely because larger tracts of land can be acquired and protected in these watersheds. This information can be useful for directing the funding for future priority projects, such as by focusing on identifying new opportunities to restore areas in urban landscapes. Further analysis of NEPORT and other data is needed to discern the locations of actual restoration projects. In general, protection is prioritized in less developed areas whereas restoration is prioritized in more developed areas.

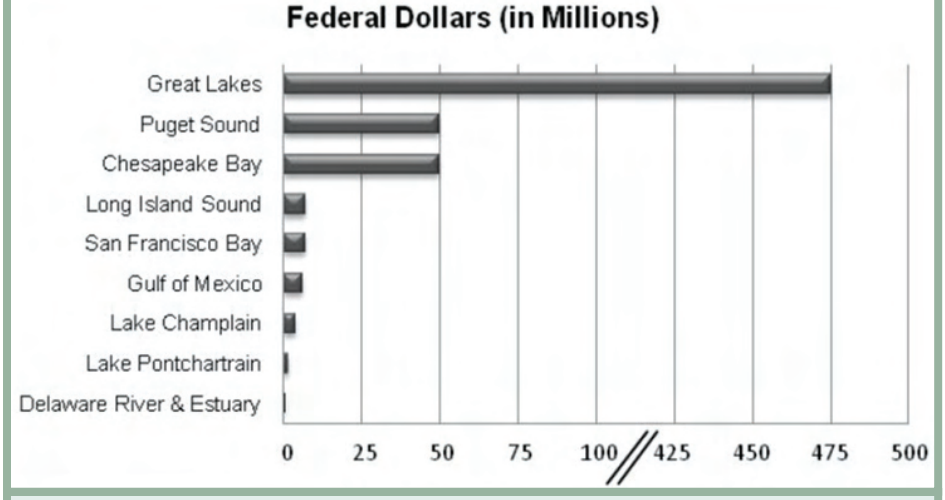

Fig. 8.8. Comparison of US EPA federal spending in FY2010 on environmental management and restoration in nine major water bodies in the United States (from Strackbein and Dawson 2011)

3.5 Actions and Needs

Until sufficient funding can be generated to materially stem losses of natural lands and restore critical habitats in the Delaware Estuary and Basin, management targets will need to be tempered and continued net losses of vital habitats will unfortunately still occur. There are a number of current efforts (PDE and others) to increase efficiency, implement strategic science-based priorities, and coordinate restoration activities. These include PDE's Regional Restoration Initiative and The Nature Conservancy's Delaware River Basin Conservation Initiative. However, these efforts will have limited benefits if restoration needs continue to be largely unmet because of stagnant and low levels of restoration investment across the Delaware Estuary and Basin.

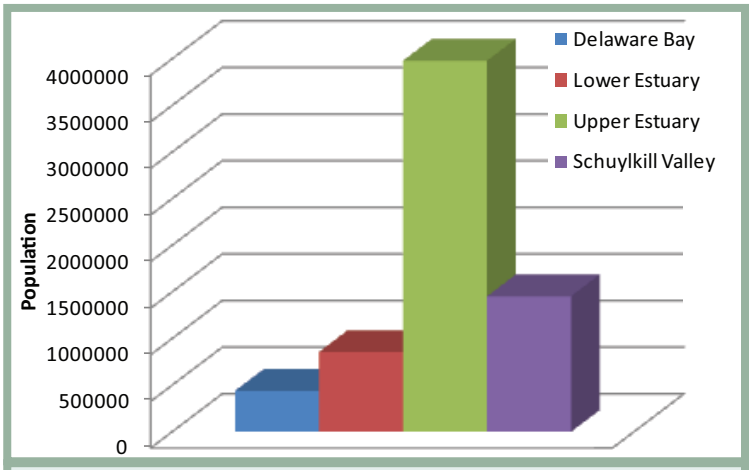

Fig. 8.9. Comparison of human population in the four watersheds of the Delaware Estuary

Therefore, the top restoration need is funding, which can be justified by the economic value of the resources that are being eroded every day. There are several efforts underway to raise awareness of the need and to build support for directed federal investment, including an effort to pass the Delaware River Basin Conservation Act mentioned in previous sections of this report. If successful and authorized, this would provide $5 million for the entire basin. Whether these efforts will be successful and how these funds will be used/prioritized to meet the needs of the estuary and basin is not clear.

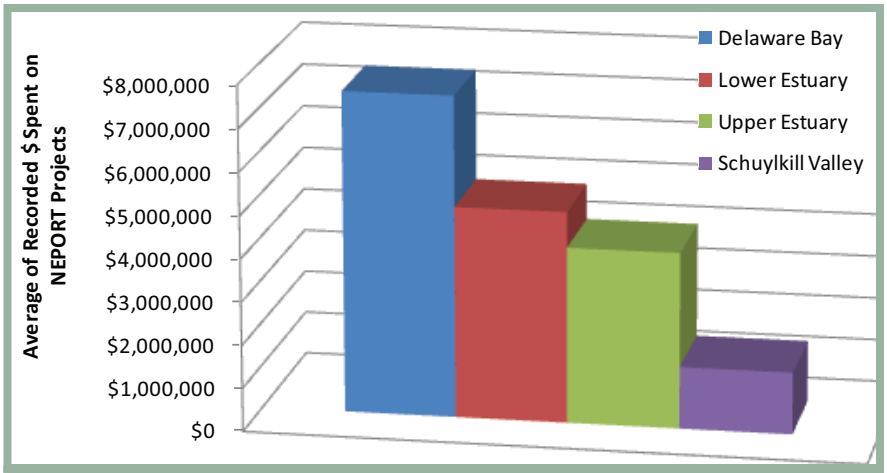

Fig. 8.10. Comparison of average $ spent between 2001 and 2011 in each watershed

In its Regional Restoration Initiative, the Partnership for the Delaware Estuary proposed the concept of a *Delaware Estuary Basin Science & Restoration Trust* (Kreeger et al. 2006, PDE 2009), that with sustainable and significant funding, would be capable of addressing diverse restoration needs associated with key living resources, habitats and water resources and which is science-based and guided by strategic monitoring and assessment data. Such a Trust would be maintained and operated by Trustees representing federal and state agencies and other groups that have worked together to develop shared, consensus-driven regional restoration priorities. In 2010 the PDE Alliance for Comprehensive Ecosystem Solutions was created based on this model, but without a designated source of funding. This public-private Alliance meets annually to assesses, prioritize and begin promoting a set of priority restoration projects for the Delaware Estuary each year. Without a designated source of funding it relies entirely on the existing resources of its partners to support projects, and so has mainly been successful at drawing attention and pooling existing resources to focus on priority projects. However, it is a framework that can be quickly and easily adapted and expanded into the more comprehensive funding Trust originally envisioned, in the case that a source of funding emerges or is created.

Sources of financing for a Trust were explored by PDE with help from the Delaware Community Foundation, the Environmental Finance Center (EFC 2007), the Global Environmental Technologies Foundation, and the Keystone Conservation Trust. The funding mechanisms identified by those efforts require more policy capacity and influence that PDE has – a challenge PDE has been working to address but which has been exacerbated by economic and political conditions in recent years.

In brief, the Trust would provide a new vehicle for accepting and pooling funding from a variety of sources to meet diverse needs, including funding priority restoration and protection projects elevated through the Regional Restoration Initiative. It could include numerous operating centers where contributions could be earmarked for specific protection, restoration, monitoring or scientific activities. The vision is for the Trust to direct and fund wise investments in the future of the Estuary.

3.6 Summary

The Delaware Estuary has significant restoration needs related to restoration of both ecosystem services, including those having significant economical consequences, and the health of local and regional communities. The main need in the Delaware Estuary is a regional restoration approach that can prioritize restoration needs, track restoration projects, identify and fill project gaps, and supply funding for high value projects. This will require coordination and sharing among various sectors and most importantly, development of a sustainable source of funding for restoration. Ideally, a broad-based Science and Restoration Trust is needed that would fund substantially more restoration and protection while also providing support for the science and monitoring that is needed to strengthen the scientific basis for restoration decision-making and outcome tracking.

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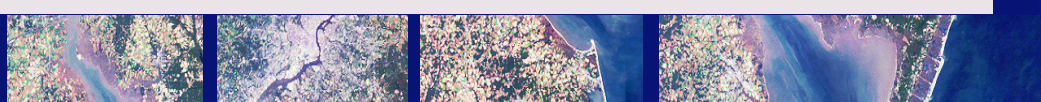

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