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TECHNICAL REPORT FOR THE ESTUARY AND BASIN

Restoration

Partnership for the DELAWARE ESTUARY

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TECHNICAL REPORT FOR THE ESTUARY AND BASIN

8 Restoration

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8. Restoration

Abstract

The goal of this chapter is to present an assessment of the current state and perceived trajectory of ecological restoration and its related factors since 2017. Data from EPA's National Estuary Program's Online Reporting Tool indicated an increase in restoration since the 2012-2016 time period, while protection/maintenance remained largely constant. A poll of restoration practitioners indicated a generally positive trajectory regarding innovation, investment, implementation, monitoring, and outreach, but still had concerns regarding the complexity and level of effort required by the regulatory process. Recommendations include the further development of cross-sector relationships to move towards greater regulatory ease especially to facilitate innovative tactic implementation, as well as increased partnerships between larger, more established, and community-based restoration entities to promote a more equitable distribution of restoration funds. Finally, larger projects that target ecosystem-based restoration will be needed to promote greater resiliency in the face of a changing climate and sea level rise.

Introduction

The goal of this chapter is to present gathered information on various important aspects associated with ecological restoration efforts within the Delaware Estuary. Further, this chapter will present an assessment of the current state of ecological restoration and where certain aspects of ecological restoration have progressed, regressed, or remained static since the 2017 reporting.

Although no entity has quantified the cumulative management and restoration progress across the entire Delaware River Basin, an initial summary was provided for the lower basin in 2012 from the National Estuary Program Online Reporting Tool (NEPORT). Later, the restoration indicator was updated in the 2017 Technical Report for the Delaware Estuary and River Basin. This was the most recent occasion in which the restoration indicator was updated.

The indicators presented in this chapter serve to provide information on three areas related to restoration efforts in the Delaware Estuary:

1. Trends in measurable size (acres) of previous and ongoing restoration efforts;
2. Trends regarding the types (diversity) of prior and ongoing restoration efforts; and
3. Information on restoration-adjoining influences (i.e., innovation, level of investment, regulatory climate, implementation, monitoring, and outreach), provided by polling qualified professionals who work in the restoration sciences.

This chapter includes a synthesis of the three aforementioned items to provide context for the current state of restoration practices and to help guide the development of an estuary-wide vision toward improving restoration technology, understanding, cooperation, and strategy to optimize restoration efforts in the Delaware Estuary.

When evaluating restoration, it is important to recognize how "restoration" fits into the umbrella framework of "resource management." Resource management consists of three fundamentally distinct areas: preservation, restoration, and maintenance. Preservation may include physical and/or regulatory resource protection, acquisition, and buffering. Maintenance can include maintaining the status quo by activities associated with fieldwork and surveys/monitoring. Restoration is the practice of engaging in an action that increases a resource in terms of habitat size, quality, diversity, etc., which leads to a net gain in ecological functions and values. As a general rule, preservation and maintenance tend to be more often practiced due to lower levels of uncertainties and implementation risk, while restoration carries with it higher uncertainties and higher implementation risk. As such, restoration is harder to fund, gain approval for, and is proportionately the least practiced of the three resource management areas. Alignment between planning and funding is crucial. Often, design projects are not "ready" when construction funds become available, or conversely designed projects (from conceptual to 100% engineered) are not implemented because funds are not available. The ebb and flow of funding create a moving target to align with restoration needs. It is widely viewed that more intensive restoration will be required to combat these changing base-level conditions.

In this way, preservation/maintenance and restoration work together to sustain natural resources (at their current condition or in line with their natural evolution, if still practical) and the services they provide. For areas experiencing severe stress from a variety of sources like anthropogenic pressures or climate change, restoration can play an important role. If one area is not implemented with the others, the resource management underachieves or even breaks down. The severity of the impaired system and the magnitude of the goals (both habitat- and species-specific) will affect the balance in which preservation, management, and restoration are applied (i.e., restoration may have the largest role in severely impaired systems which are epicenters for impaired species of concern). The absence of natural or man-induced restoration makes it nearly impossible for long-term natural resource sustainability. Nature has some level of resilience, a sustainable capability combined with a healing component. But depending on what the drivers and goals are for a particular resource, natural resilience may not suffice in the face of rapid base-level changes and a system decoupled due to human perturbation or natural disasters and fluxes.

Similar to resource management, restoration can be further classified into three subgroups: creation, enhancement, and governance, with governance being an increasingly significant factor in modern-day restoration. Creation involves establishing functions and values for a resource where one was not currently present. Enhancement generally is defined as improving something that currently exists. Governance is the political, regulatory, and education component of restoration (Fig 8.1). Socio-based drivers and obstructions have been demonstrated to periodically alter the governance aspect of restoration. For the purposes of this section, governance will mean non-physical influences. The response to Superstorm Sandy brought about a rapid integration of new partners in restoration, advancements in technologies, a willingness to push the boundaries with respect to scale and regulatory framework, and a willingness to invest in restoration initiatives, but to some extent, those advancements have stalled or been overshadowed by certain elements of the community who are less willing to take risks, have a lack of understanding, and/or have a reluctance towards change.

Additionally, one other significant factor considered in this chapter is the influence of restoration technology. The extent of development, testing, and implementation of restoration technologies, in the face of today's climate-based and socioeconomic challenges, may greatly influence public and political opinion and could be considered the catalyst in determining the scale of landscape-scale restoration implementation success or restoration stagnation and failure. Caution in the use of experimental technologies or larger scales is required, but our current technological state and resistance to change in methodologies can become a hindrance or wall. Restoration technology is concurrently limited with room for continued development driven by creativity, expertise, and scientific commitment. There is a need for technically-based development, testing, and evaluation and a willingness to take calculated risks in efforts to improve the technology of new techniques. Unfortunately, there are limited individuals and programs who are willing and able to fill that role. Our environment and climate are ever-changing, meaning technology does not have the luxury to "rest on one's laurels."

Restoration Indicators

In common usage, the term "restoration" implies some form of remediation or improvement that returns a resource or certain resource functions to some former condition or location. In some cases, however, targeting historic conditions is inappropriate because the viable location for a resource or habitat may have shifted in response to changing environmental conditions (e.g., salinity, tidal inundation, temperature). In other cases, the structure and function of restored systems may never match that of undisturbed systems, and various tools are used to set appropriate criteria that define a project's success. In acknowledging the difficulty of fully repairing disturbed systems, restoration practitioners have adopted various definitions of restoration and restoration-type activities. For example, in its 1992 report titled Restoration of Aquatic Ecosystems, the National Research Council defined restoration as the "return of an ecosystem to a close approximation of its condition prior to disturbance." The Society for Ecological Restoration defines ecological restoration as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed." Additionally, New Jersey, Delaware, and Pennsylvania all have regulatory definitions for each term, but this document will focus on the broader definitions which generally apply in each state.

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

This chapter reports on two restoration indicator categories: physical and non-physical (Fig 8.1). ***Physical indicators*** refer to discrete, on-the-ground restoration applications. This TREB reports on the following physical indicators: ***number of acres restored and protected***, their respective ***habitat*** types, and associated ***dollars spent***. These indicators have been reported in previous TREB reports and attempt to track the progress of landscape-level restoration activities. Restoration success would be an ideal indicator to include but is harder to track due to a lack of data regarding the proportion of individual projects that have been able to meet defined goals through the tracking of relevant metrics. The application of goal-based monitoring frameworks, such as the ones developed in NJ and DE, coupled with a project progress registry would facilitate this type of tracking. Although these physical indicators can provide a summary of restoration progress, they are influenced by a variety of non-physical activities and circumstances that provide context to the quantifiable restoration activities. For example, if there is a drop in the number of annual acres restored, this may not be due to a lack of effort by restoration practitioners but may be a result of the influence of changes in available funding or regulatory requirements. Additionally, a decline in the restoration activities of a specific habitat may result in a divergence between the innovative expectations of a funding entity (e.g., hesitant to fund unproven tactics), the region's practitioners (e.g., submitting innovative project designs), or a shift in interest between habitats within the restoration community. In this TREB effort, six ***non-physical indicators*** have been selected for evaluation to provide context for the physical indicators and to drive discussion regarding the future direction of restoration in the Delaware Estuary: ***innovation, level of investment, regulatory climate, implementation, monitoring,*** and ***outreach***.

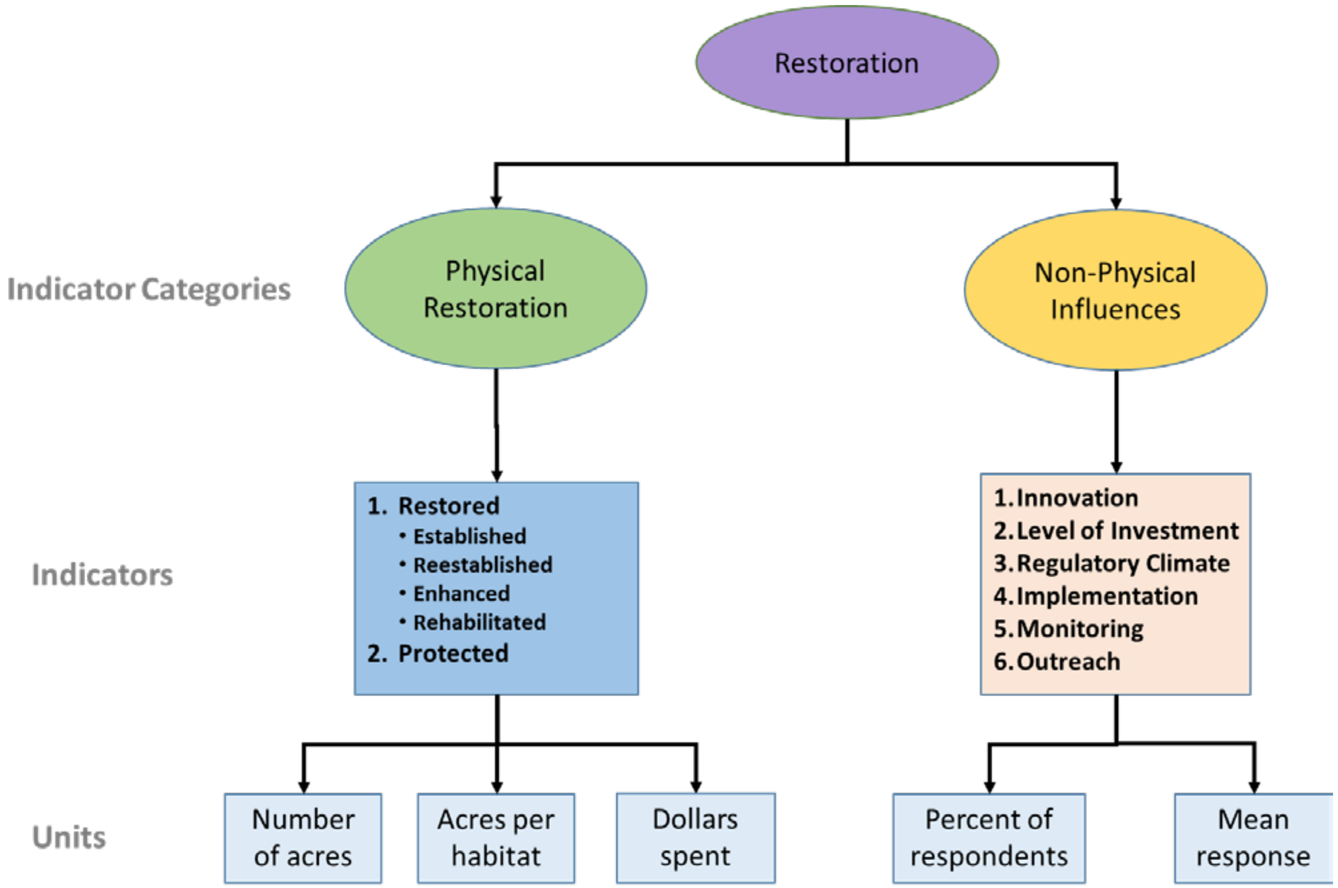

Figure 8.1 Diagram of restoration indicators nested in either physical restoration or non-physical influences categories with their associated reported units. Data for physical restoration indicators were compiled from the EPA NEPORT reporting system, and data for non-physical indicators were collected through a survey of restoration practitioners and other individuals in adjacent professional fields (e.g., regulatory agents, academic researchers).

8.1 Physical Restoration

Description and Methods

Restoration data from multiple states and programs are challenging to collect and analyze, and many important resources are found in the Delaware Estuary and Basin. 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 and lack of standardized reporting among the many different agencies and programs that are responsible for the restoration. One of the most straightforward ways to track habitat restoration is to determine acres restored annually, focusing on voluntary actions (and not reparative, regulatory-based actions such as mitigation projects). Ideally, restoration activities should also be assessed for specific habitat types. In the future, it would be beneficial to also assess the functionality to restored habitats, since a particular site could be “restored” significantly without any net increase in acreage. Since no database exists to track watershed-wide restoration, as a starting point for this effort, we discuss acreage data that have been reported as restored (and/or protected) by each state (New Jersey, Pennsylvania, and Delaware) annually using EPA’s National Estuary Program 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 as part of the goals of the 1996 Comprehensive Conservation Management Plan (PDE 2019) for the Delaware Estuary. Unfortunately, there is no coordinated tracking system at this time to determine how many net acres have been restored or gained/lost in the watershed, and NEPORT is not comprehensive as it reflects only those data that have been voluntarily provided by partners of the Partnership for the Delaware Estuary. Since NEPORT is not comprehensive and generally focuses on the lower half of the Delaware River Basin, data for this indicator is largely conservative at the watershed scale. However, since this NEPORT reporting approach has been active for more than a decade it is possible to examine broad restoration trends using NEPORT data as an indicator, but it should be noted that EPA occasionally modifies the NEPORT data collection and reporting process. Another advantage of NEPORT data is that the tracking program excludes actions associated with mitigation (e.g. Natural Resource Damage Assessment, Supplemental Environmental Project), 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. NEPORT tracks restoration data in four categories which are used in this chapter to explore and evaluate restoration progress in the Delaware Estuary:

- **Establishment** (also referred to as "creation") is the manipulation of physical, chemical, or biological conditions to facilitate the development of a target habitat that is representative of natural conditions but that did not previously exist at the project location. Establishment results in acres gained 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, established wetlands are created by the excavation (or addition) of upland soils to achieve elevations that will support the growth of wetland species through the establishment of 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 the structure and/or function without an increase in acreage.

- **Rehabilitation** is similar to enhancement and is defined by the US EPA as the manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing the 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.

- **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 for public parks, 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 ecological function, they do not result in net habitat gains. Although not a direct restoration activity, protection might be considered restoration progress towards a net increase in ecosystem function, relative to no action or loss, and as NEPORT tracks protection efforts, they are included here.

In addition to assessing the amount of area restored in the aforementioned categories, NEPORT also tracks the types of habitat per category to ensure that restoration progress reflects the balance of habitats that have suffered the most degradation. Healthy estuaries depend on a complex mix of habitats, with each estuary possessing a 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. 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. For example, coastal wetlands are a hallmark feature of the Delaware Estuary and are critical for supplying diverse benefits to people and the environment, and we have lost more than half of our coastal wetlands mainly due to direct filling and development (see Chapter 6.3). Forests are similarly vital for sustaining source water quality and other services, and forest losses continue to be swift due to development (see Chapter 6.1). To get the greatest benefits, voluntary (non-mitigation) attempts to rebuild these habitats should reflect the natural balance of types that characterizes the watershed. Data from NEPORT were examined to discern the types of habitats that have generated the greatest restoration attention since 2006.

8.1.1 Acres Protected and Restored

Present Status

Recent restoration progress was examined qualitatively by contrasting the types of efforts made in the Delaware Estuary from 2006-2021, as reported in NEPORT. Since 2006, a generally equal amount of land has been protected and restored (Fig 8.2a). Enhancement and rehabilitation accounted for 92% of the restoration activities and were similar in percent of total areas restored. Since 2017 when the last TREB was published, restoration activities accounted for 58% of the total activities, with rehabilitation and enhancement accounting for 98% of the area restored (Fig 8.2b). As protection does not necessarily improve ecological conditions, NEPORT does not give a clear representation of actual net ecological improvement.

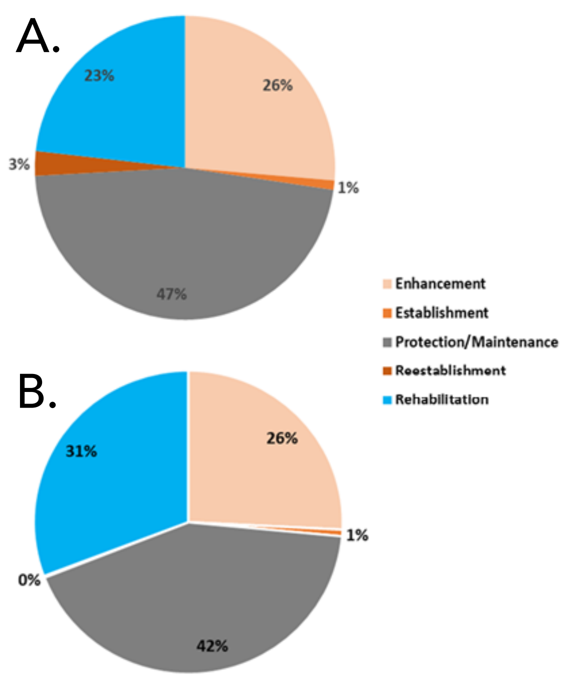

Figure 8.2 Proportions of the land area (acres) protected vs restored (i.e., enhancement, establishment, reestablishment, and rehabilitation) 2006-2021 (a) and 2017-2021 (b, period since last TREB) as reported in NEPORT.

Past Trends

As a National Estuary Program, PDE is responsible for setting restoration goals every year. Since the advent of NEPORT tracking in 2000, the total number of acres reported to NEPORT each year represents a modest 0.017% of the total area of the Delaware River Basin. As noted above, tracking restoration is challenging because PDE must rely on voluntary reporting by partners. Annual variation in restoration investment also takes place since projects are typically grant-funded and are subject to fluctuating availability of funds. Despite these caveats, restoration progress since 2006 has been considerable, typically exceeding the annual goal set by PDE and US EPA for the combination of protected and restored acres (Fig 8.3). Prior to 2011, this annual goal was 2,250 acres. Due to declining acreage that was protected or restored between 2007 and 2010, this annual goal was changed in 2011 to1,500 acres. In multiple single years since 2006 protection efforts surpassed restoration efforts, largely due to data reporting from programs such as New Jersey Green Acres which provides funding for land acquisition projects (Fig 8.3). However, in each of the last three TREB reporting timeframes, cumulative restoration activities (i.e., enhancement, establishment, reestablishment, and rehabilitation) have accounted for more area per period than protection/maintenance efforts (Fig 8.4). Interestingly, restoration activities appear to spike in 6-year cycles (Fig 8.4 - 2007, 2013, & 2019), potentially related to funding cycles (Fig 8.3).

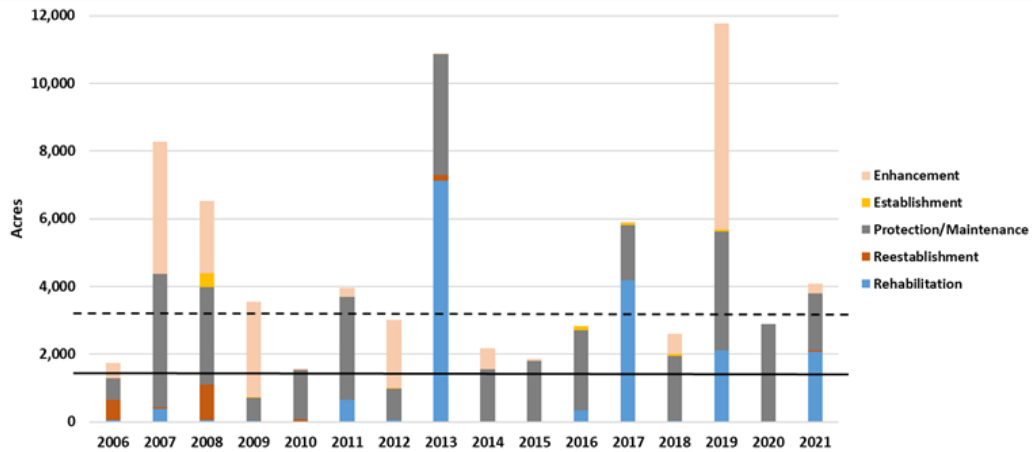

Figure 8.3 Acres restored and protected annually between 2006 and 2021, with the four types of restoration reported separately. For comparison, the annual NEPORT goals are shown for 2006–2010 and 2011–2021 (dashed and solid black lines, respectively).

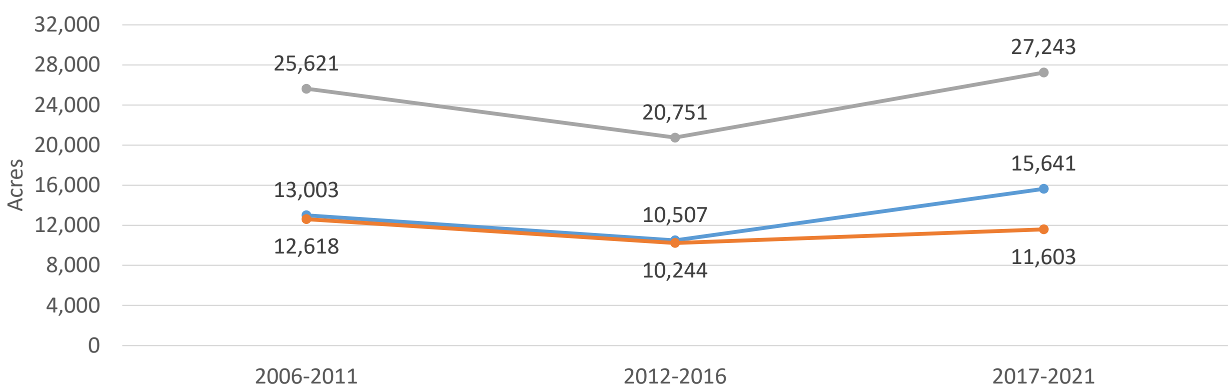

Figure 8.4 Total areas restored (blue), protected (orange), and cumulative (gray) for approximately each of the last three TREB reporting periods.

8.1.2 Habitat Types Protected and Restored

Present Status

Cumulatively since 2006, forests/woodland (32%), tidal wetlands (24%), and forested wetlands have had the greatest acreage restored or protected (Fig 8.5a). This ranking is similar to the 2017-2021 data with the exception of beaches (10%) having the third-largest area restored/protected, and forest/woodland accounting for a greater proportion of the total acreage (47%, Fig 8.5b).

Past Trends

The amount of area protected and restored varies widely among years and among habitat types (Fig 8.6). This variability is due mainly to fluctuations in 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, the potential of an overall downward trend hypothesized in the 2017 TREB is not as apparent in 2021, largely due to stable activity between 2016 and 2021, as well as the large increase in 2019 (Fig 8.6). Grouping activities by restored (enhancement, establishment, reestablishment, and rehabilitation) and protected, the decline observed in both activities in the 2017 TREB (2012-2016) did not continue, and increases in the restoration and protection were present in the 2017-2021 data (Fig 8.7). Of note are substantial increases in restoration of tidal wetlands, beach, and agriculture, while field and meadow and riparian activities were not reported.

Trajectories and 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. 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, and as predicted increases in funding become available. For example, water resources in the Delaware Estuary sustain a $10 billion per year economy, and the loss and degradation of natural systems is certain to have serious economic consequences (Kauffman 2011). In the short term, we anticipate that restoration progress could be undermined if federal investment in environmental programs is reduced, as has been proposed. Fortunately, non-profit organizations such as the National Fish and Wildlife Foundation, in partnership with USFWS and William Penn Foundation, have recognized the importance and scale of the restoration need, contributing substantial resources through the Delaware River Program's

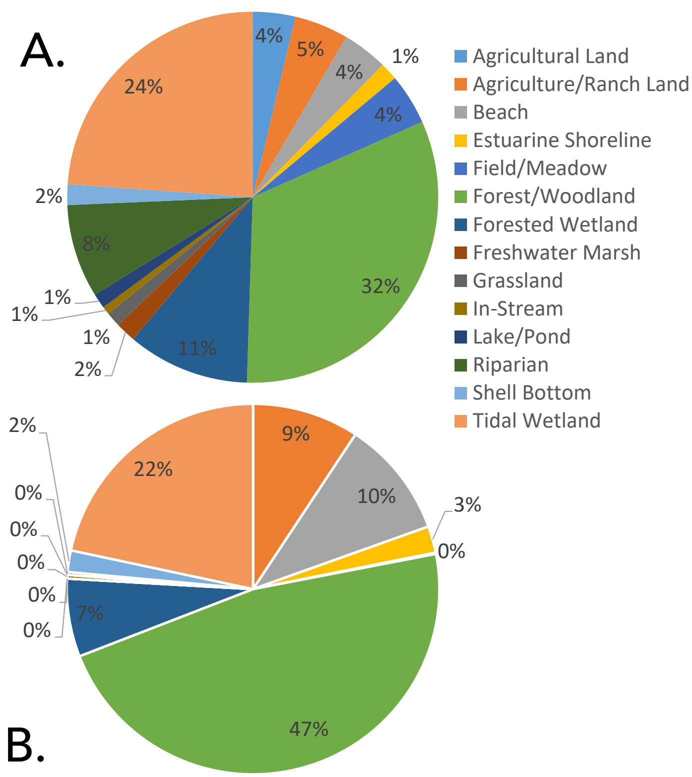

Figure 8.5 Proportions of the total habitat area (acres) either protected or restored (i.e., enhancement, establishment, reestablishment, and rehabilitation) 2006-2021 (a) and 2017-2021 (b) period since the last TREB as reported in NEPORT.

Delaware Watershed Conservation and Restoration Funds to support habitat restoration. With sustained or increased investment by other state and local entities, and potentially new public-private partnerships, we anticipate that the Delaware Estuary Program will continue to meet the annual 1500-acre goal. Trajectories and predictions are further discussed through the context of the non-physical indicators in *8.2 Non-Physical Influences and Efforts.*

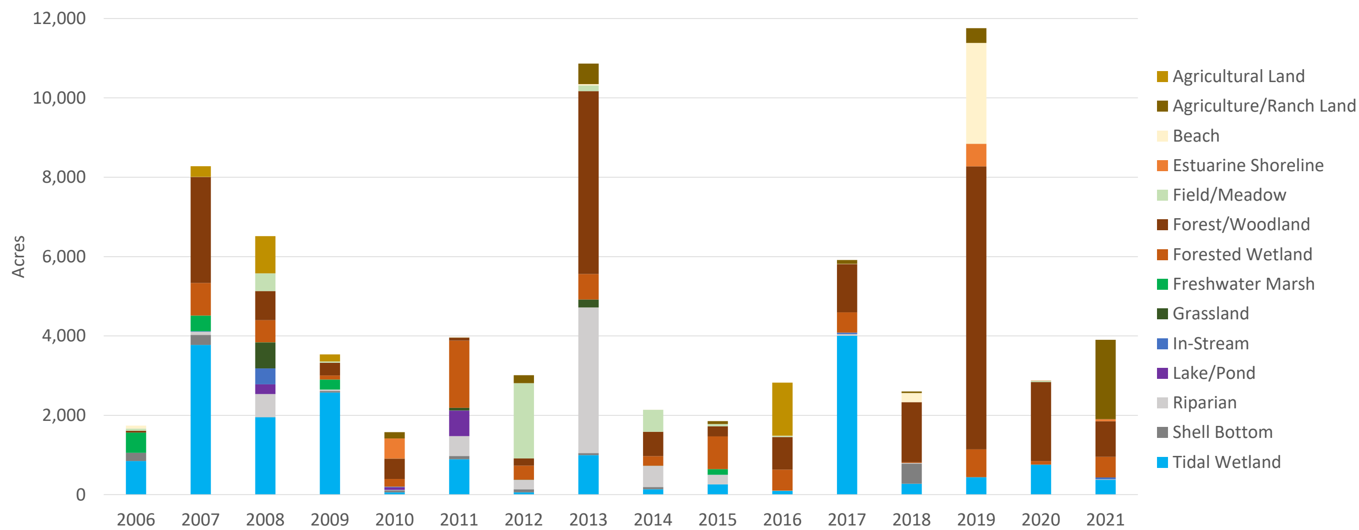

Figure 8.6 Acres restored and protected annually per target habitat between 2006 and 2021.

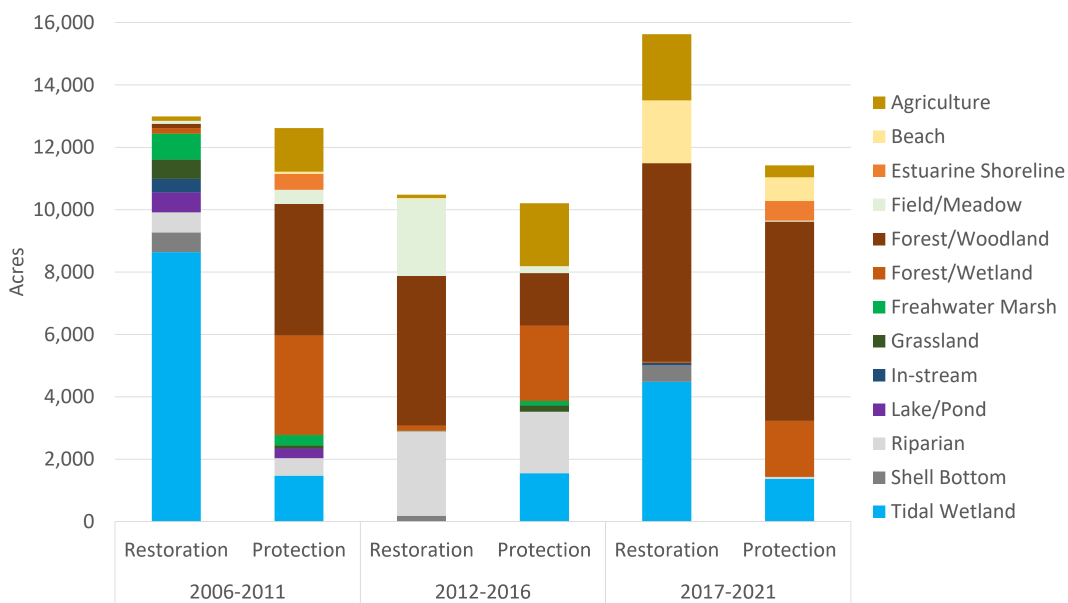

Figure 8.7 Acres restored and protected per habitat between 2006-2011, 2012-2016, and 2017-2021.

As noted in the habitats chapter of this document, more than half of tidal wetlands have been lost in the Delaware Estuary compared to pre-settlement conditions, and between 1996 and 2010, nearly 2% of tidal wetland acreage was lost. Future projections suggest that 119,000 acres (48,000 hectares) will be lost by 2100, assuming that the sea level rises by one meter (Kassakian et al. 2017; Kreeger et al 2010). Forests continue to be lost at an even faster rate, and the cumulative impacts from the development and other contemporary challenges threaten to hasten loss rates in the future. Continued focus on tidal wetlands and forests is therefore warranted. Other habitats that have been prioritized such as shellfish beds are arguably even more vital, but they are also smaller in size and harder to capture in terms of acres.

Unfortunately, hundreds of thousands of acres of natural habitats have been destroyed or significantly altered in the Delaware Estuary watershed during the past 15 years despite many governmental protections (see Chapter 6). One of the top goals in the Comprehensive Conservation Management Plan (CCMP) for the Delaware Estuary is the restoration, protection and enhancement of natural habitats (strategies H1.2, H1.3, H1.4, H2.3, H3.1, H3.2, and H3.4, PDE 2019). 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 those associated with development. The balance of habitat types restored and protected in the past 11 years can be analyzed with data from the NEPORT. Since 2006, 66% of money spent was for protection relative to restoration efforts cumulatively, and was generally greater annually (Fig 8.8). The large increase in rehabilitation in 2017 can be attributed to a single $38 million berm and dike modification project focusing on tidal wetland habitat (Figs 8.8 and 8.9). The contribution of this single project accounts for 72% of the 2017 total dollars spent and 41% of the total restoration dollars spent between 2006-2021. 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 2006 .

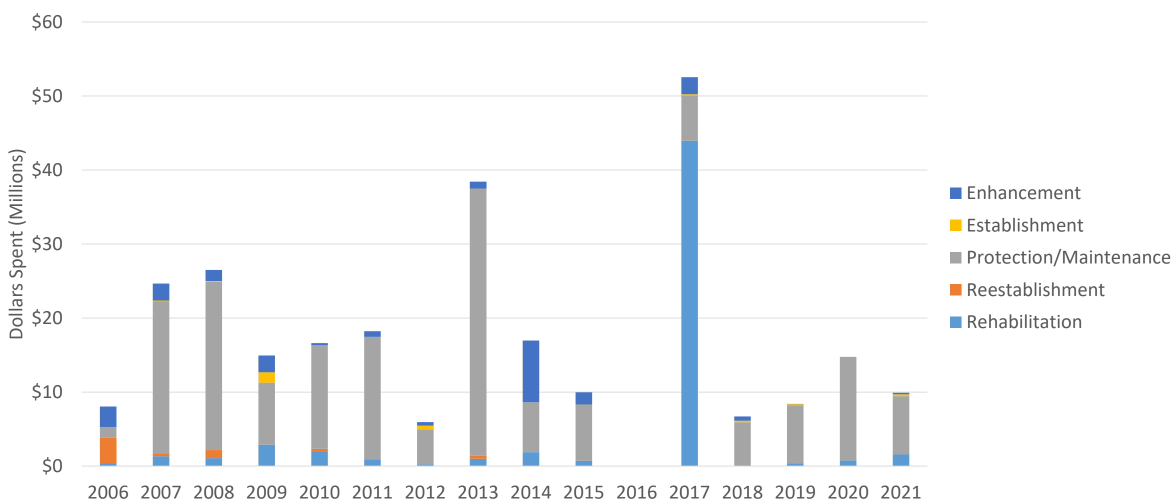

Figure 8.8 Dollars spent for restoration (broken out by four types) and protection between 2006 and 2021.

Unless funding and capacity for natural areas restoration is significantly increased within the Delaware River Basin, it will be vital that the limited investments be spent wisely through the prioritization of key areas and habitat types that are most critical to the character and functionality of the Delaware Estuary, using the best available scientific data. A complementary approach utilizing the wealth of monitoring data generated by DELEP partners and newly developed restoration prioritization tools can be used to guide strategic investments. Ultimately, for effective restoration at the regional scale, a balance needs to be maintained between innovation, investment, and outreach. To protect habitats to the best of our ability, proven techniques need to be employed, but as stressors change we need to be prepared to envision and test new methodologies. Implementation will be driven by funding availability for the tried and true as well as innovative projects, coupled with regulatory mechanisms to facilitate their application and evolve with lessons learned through monitoring. Finally, dissemination of knowledge through outreach will help to engage stakeholders and temper expectations regarding effects and timelines. These non-physical influences on restoration practices are evaluated and explored in the following section.

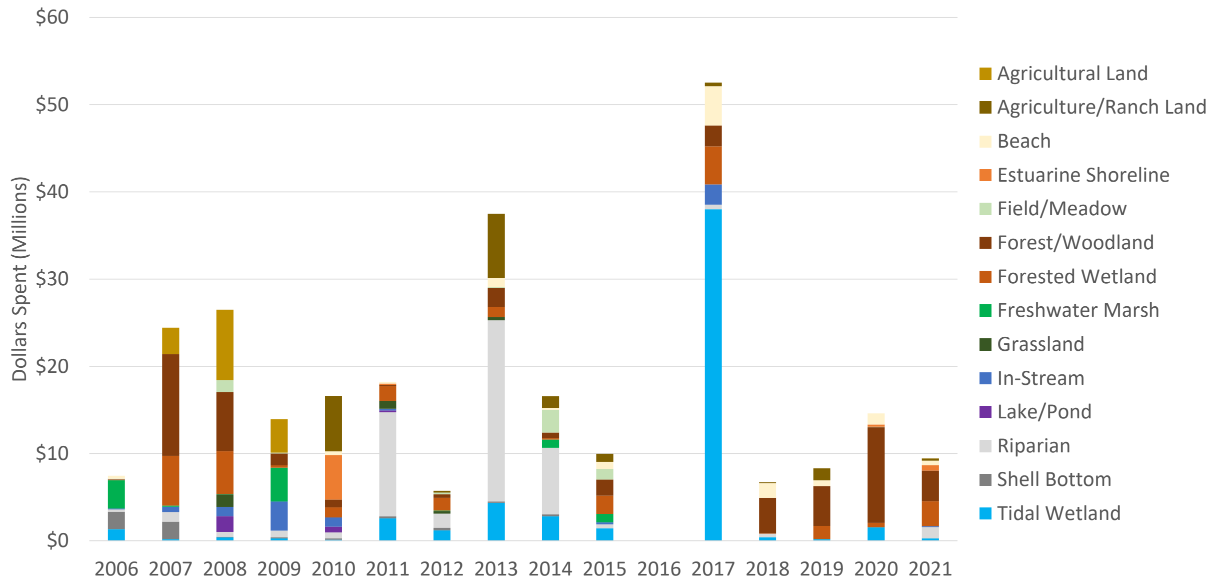

Figure 8.9 Dollars spent on restoration and protection annually per target habitat between 2006 and 2021.

8.2 Non-Physical Influences and Efforts

Description and Methods

Data for non-physical indicators were collected through an online questionnaire. The questionnaire consisted of 45 questions (Appendix 8.A) asking the respondent to select the best answer based on their experience across the following categories (q=number of questions per category):

- **Respondent Information** (q=7): Introductory questions for the evaluation of the sample pool to help provide context to the questionnaire results. The questions accounted for the respondent's area of expertise, time involved in restoration, and current sector

- **Innovation** (q=5): Innovation questions aimed to quantify the perception in the development of new ideas and approaches or new applications of existing ideas and approaches. Innovation can be applied to restoration techniques, technology, and/or tactic design or implementation.

- **Level of Investment** (q=5): These questions asked the user to consider changes in factors related to funding opportunities for restoration efforts.

- **Regulatory Climate** (q=6): These questions asked the user to reflect on changes in regulatory considerations, permitting, and time frames as they relate to restoration project requirements and implementation.

- **Implementation** (q=5): Implementation refers to the actual execution of restoration activities at a specific location, such as construction, deployment of fill material, excavation, or any activity that alters or adds to the landscape. These questions asked the user to relay their experience related to on-the-ground activities.

- **Monitoring** (q=6): Monitoring refers to any activity conducted with the explicit intent to collect information related to any facet of the project that will be used to better understand one or more processes potentially affected by the restoration activity. This can include project monitoring conducted on consistent, sporadic, or opportunistic time frames, and for required (i.e., permit requirement) or optional (i.e., principal investigator/partner initiated) activity. These questions asked the user to relay their experience related to these activities.

- **Outreach** (q=6): Outreach refers to activities intended to disseminate information regarding restoration needs, activities, and/or results to any stakeholder (e.g., different sectors, the general public, educators, other practitioners). These questions asked the user to relay their experience related to these activities.

- **Additional questions** (q=5): These questions required answers that could not be specifically fit into a standardized set of options (see below), and were asked individually. All were related to categories 2-7 above and were used to provide additional context to average categorical responses (see below).

Invited respondents (n=155) were selected for their direct knowledge and/or expertise regarding restoration activities in the Delaware Estuary. Respondents were sourced from the following groups:

- PDE committee members: Ecological Implementation Committee (EIC), Science & Technical Advisory Committee (STAC).

- Regional ecological committees and work groups: Delaware Living Shorelines Committee, NJ Coastal Resiliency Collaborative, Tidal Wetlands Monitoring Network, and the DE & NJ Salt Marsh Work Group.

- Regional NGOs: The Nature Conservancy, American Littoral Society, DE Center for Inland Bays, and Barnegat Bay Partnership.

- State entities: NJ and PA Departments of Environmental protection and DE Department of Natural Resources and Environmental Control - additionally, potential respondents were selected from multiple internal sectors, including the regulatory divisions.

- Federal entities: Environmental Protection Agency Regions 2 and 3, US Fish and Wildlife Service, and the Army Corps of Engineers.

- Restoration practitioners who are directly involved in one or more of the interview categories.

Although not all respondents' work singularly focuses on activities in the Delaware Estuary, their time and experience led to accumulated knowledge of these activities in the Delaware Estuary within the associated time frame of 2017–2021.

All questions were multiple-choice, with the exceptions of the demographic and the additional questions (categories 1 & 8, respectively), and asked the user to answer each question by selecting from the following list of standardized responses with associated point values in parentheses to inform analysis:

- Substantially increased (5)

- Moderately increased (4)

- Not changed (3)

- Moderately decreased (2)
- Substantially decreased (1)

Standardized responses, although more general in terms of the detail of information provided per respondent, allowed for the calculation of some summary statistics that reflect the general thoughts of the group as a whole. The evaluation included the relative proportion of responses and mean response per question, and by calculating a grand mean response per category (e.g., innovation, regulatory climate). Mean responses were assigned factor levels as follows:

- Substantially increased: 4.01-5.00
- Moderately increased: 3.01-4.00
- Not changed: 3.00
- Moderately decreased: 2.99-2.00
- Substantially decreased: 1.99-1.00

Results

Respondent Demographics

A table of responses is provided for each question below. Responses with the highest percentages are highlighted in green.

Sectors of questionnaire respondents were represented variably, with the highest percentage of respondents coming from state and federal agencies (Table 8.1). The majority of respondents have been involved with restoration in the Mid-Atlantic region for 10–20 years, while the lowest percentage of respondents has been involved less than three years (Table 8.2).

The habitats that questionnaire respondents worked in more than any others were tidal freshwater and upland habitats, with many respondents working across categorical options (Table 8.3). The top three areas of involvement indicated by respondents were site evaluations, monitoring, and project design, followed closely by installation and outreach (Table 8.4).

The majority of respondents indicated that the organization they represent is not a partner of DELEP or a member of any DELEP committees such as the STAC or the EIC (Table 8.5). While a majority of respondents do not represent DELEP-affiliated organizations or sit on any DELEP committees, about two-thirds of questionnaire respondents indicated that their organization has partnered on projects with PDE (Table 8.6). The majority of respondents indicated that the organization they represent is not a partner of DELEP or a member of any DELEP committees such as the STAC or the EIC. While a majority of respondents do not represent DELEP-affiliated organizations or sit on any DELEP committees, about two thirds of questionnaire respondents indicated that their organization has partnered on projects with PDE.

Table 8.1 Percentage of respondents who selected each response regarding their affiliated sectors.

#	Demographics Questions	Federal	State	Private	Academic	NGO	Other
2	Sector:	23%	23%	18%	9%	20%	7%

Table 8.2 Percentage of respondents associated with respective years involved in the restoration field in the region. Years 3-5 are those since 2017.

#	Demographics Questions	0-3	3-5	5-10	10-20	20-30	30+
3	How many years have you been involved with restoration in the Mid-Atlantic?	6%	10%	28%	30%	14%	12%

Table 8.3 Percentage of respondents associated with each environment associated with restoration practice in the Delaware Estuary.

#	Demographics Questions	Upland	Tidal Freshwater	Tidal Brackish/ Saltwater	Non-tidal Freshwater	All of the above	Other
4	Typical working habitat (choose up to 3)	23%	23%	18%	9%	20%	7%

Table 8.4 Typical restoration practice of respondents. Note that participants were able to select as many options as they wanted and that the number for each option in the table indicates the number of times that option was chosen, not a percentage of participants that chose it.

Demographics Question #5	
What area of restoration practice are you typically involved in (choose all that apply)?	#
Site evaluations	55
Distributing funds	25
Project design	50
Permitting	38
Installation	48
Monitoring	51
Training	20
Outreach	45
Regulating	10
Other	13

Table 8.5 Percentage of respondents affiliated or not affiliated with DELEP organizations or DELEP-partnering organizations.

#	Demographics Questions	Yes	No
6	Is your organization a Delaware Estuary Program (DELEP) partner or a member of any DELEP committees? DELEP partners are a group of regional organizations that, with PDE, work together to coordinate and implement long-term plans for the Delaware Estuary. DELEP committees include the Steering Committee, Estuary Implementation Committee (EIC), and the Science and Technical Advisory Committee (STAC).	46.99%	53.01%

Table 8.6 Percentage of respondents whose organizations have or have not partnered on projects with PDE.

#	Demographics Questions	Yes	No
7	Has your organization partnered on projects with PDE?	67.07%	32.93%

Categorical Questions

A table of responses is provided for each category of questions below (innovation, level of investment, etc…), including the percentage of respondents that selected each answer (significant increase, moderate increase, etc…), the mean response for each question, and a translation of the mean into a categorical response. Coloration for each question reflects the level of categorical; response as follows:

- Substantially increased dark green
- Moderately increased light green
- Not changed white
- Moderately decreased light red
- Substantially decreased dark red

Innovation (Q8-12)

Responses indicate a positive trend in innovation (Table 8.7). More than 74% of respondents believe there has been a positive trend in on-the-ground innovation and the use of feedback to inform lessons-learned and project design (Q8–11). Most agencies have recognized the desire and need for restoration innovation, created restoration-specific general permits with the intent to facilitate restoration projects, partnered with other entities for restoration training and demonstration projects in efforts to advance restoration science, and even performed their own restoration studies and pilot projects with at least some of the goals being associated with innovation. Generally, respondents indicated that the regulatory process since 2017 has moderately increased the application of innovation (Q12).

Although innovation tends to be trending in a positive direction over the past 5 years, there are still many challenges to overcome. Over the last 5 years, there has been a high level of turnover in the restoration community across sectors (e.g., agencies, NGOs, and the private sector) representing a loss of institutional knowledge and experience. Regarding the neutral or negative effects associated with regulatory processes (Q12), agencies may be in a difficult position regarding how to support innovation opportunities that may not align with the currently accepted categories. Most general permits, by their nature, are developed to facilitate routine, "low risk", applications, and as such these permits typically do not accommodate innovation. One aspect of innovation not addressed in this questionnaire concerns project size. Upscaling is a form of innovation due to its unique challenges relative to small projects. Elements related to managing large volumes of material, handling larger material, project coordination, project duration, permitting, monitoring, outreach, etc, can all have unexpected challenges, needs, and costs. How these elements are dealt with can be a form of innovation. Finally, although innovation can lead to technical restoration advancements, practitioners and agencies may be hesitant to embrace innovation because of concern regarding the under-performance of novel techniques. Efforts need to be made to develop innovative, multi-sector projects with the single goal of advancing the state of science and knowledge, with a science-based tolerance towards the negative implications of less than ideal outcomes. The idea of "breaking a few eggs to make a cake" applies to innovation, provided there are reasonable checks and balances. For example, appropriate monitoring and assessment can support innovation through the development of a better understanding of the appropriate application of goal-based tactics. Standardized monitoring can provide quantitative information to inform innovation needs (e.g., the need for new tactics to meet specific goals under site-specific conditions), and how to transform lessons learned from short-term failures into long-term solutions.

Table 8.7 Summary statistics for each question asked in the innovation section of the survey. Percentage of respondents that selected each categorical response are noted in columns 3-7: SI=substantially increased, MI=moderately increased, NC=not changed, MD=moderately decreased, and SD=substantially decreased. Means (column 8) were calculated based on the method described in Section 8.2, and reflect the average score among respondents per question, which is translated back to a categorical response in the last column (9). Coloration reflects increases (dark and light green), no change (white), and decreases (light and dark red).

#	Innovation Questions: Since 2017,	SI (%)	MI (%)	NC (%)	MD (%)	SD (%)	Mean	Categorical Translation
8	The use of feedback, lessons-learned, and/or results to inform project designs has ____.	22.5	58.75	16.25	2.50	0.00	4.01	SI
9	The general level of innovation applied by regional organizations has____.	11.54	69.23	17.95	1.28	0.00	3.91	MI
10	The level of innovation applied by the organization they represent has____.	21.79	52.56	25.64	0.00	0.00	3.96	MI
11	The proportion of new and proposed projects that incorporated (not just discussed) sea level rise into their design has____.	20.78	53.25	23.38	2.60	0.00	3.92	MI
12	The effects or actions associated with the regulatory process has ____ the opportunity for the application of innovation.	2.60	44.16	40.26	7.79	5.19	3.31	MI
						Overall Categorical Result	3.82	MI

Level of Investment (Q13-17)

Of note, question 16 was phrased so that an increase indicated a negative effect. To account for this in the mean calculation and overall interpretation, the categorical scores (i.e., SI =5, MI = 4, …., SD = 1) was reversed (e.g., SI = 1,…, SD = 5) for these questions (*).

Overall, level of investment is trending in a positive direction (Table 8.8). Nearly 65% of respondents believe there has been an increasing trend in restoration funding opportunities (Q13), and more than 70% believe there has been an increasing proportion directed towards implementation (Q14). Despite this perceived trend, more than 55% of respondents do not feel there has been any change regarding monitoring funding (Q15), match requirements (Q16), or recipient diversity (Q17). As such, it may be construed that the trend of increased funding may be slightly outpacing the trends associated with the administration of funding as experienced by the respondents. It is worth noting that 30.26% of respondents felt that match requirements were resulting in increased difficulties related to application submission (Q16). Although this is not the majority, it is a notable percentage of respondents.

Table 8.8 Summary statistics for each question asked in the level of investment section of the survey. Percentage of respondents that selected each categorical response are noted in columns 3-7: SI=substantially increased, MI=moderately increased, NC=not changed, MD=moderately decreased, and SD=substantially decreased. Means (column 8) were calculated based on the method described in Section 8.2, and reflect the average score among respondents per question, which is translated back to a categorical response in the last column (9). Coloration reflects increases (dark and light green), no change (white), and decreases (light and dark red).

#	Investment Questions: Since 2017,	SI (%)	MI (%)	NC (%)	MD (%)	SD (%)	Mean	Categorical Translation
13	Funding for restoration opportunities has ____.	19.48	45.45	23.38	11.69	0.00	3.73	MI
14	The proportion of available funding that is focused on implementation rather than project planning has ____.	20.78	50.65	24.68	3.90	0.00	3.88	MI
15	The proportion of available funding for project monitoring has ____.	2.60	29.87	58.44	9.09	0.00	3.26	MI
16	Match requirements have ____ the level of difficulty in applying for funds.	0.00	5.26	57.89	30.26	6.58	2.62	MI*
17	The distribution of funding across diverse recipients has ____.	6.67	30.67	57.33	4.00	1.33	3.37	MI
	Overall Categorical Result						3.37	MI

Funding sources are looking to find recipients that offer the best chance of success. Established and more networked entities likely still receive a large portion of funding, while smaller entities may be viewed as a higher funding risk. Often, these smaller entities have to rely on smaller local grants, raise their own capital, or compromise their projects to obtain funding. But smaller entities may have more personal investment in the communities in which they are located, resulting in high energy and deep commitment. Partnerships are perhaps the most effective means to get funding to the most diverse range of users while addressing many of the risk-related issues that concern funders such as financial stability, experience, and a proven track record. Larger entities are beginning to recognize the unique role and perspective smaller, community-based entities can provide including the local expertise, local support, landholdings, and commitment. Although not a perfect solution for every situation, partnerships are becoming more common and popular.

Regulatory Climate (Q18-23)

Of note, questions 18, 19, & 21 were phrased so that an increase indicated a negative effect. To account for this in the mean calculation and overall interpretation, the categorical scores (i.e., SI =5, MI = 4, …., SD = 1) was reversed (e.g., SI = 1,…, SD = 5) for these questions (*).

Overall, respondents felt there was a moderate decrease in restoration project facilitation from the regulatory sector (Table 8.9). Although respondents felt there was a moderate increase in permit options (Q20) and in-agency willingness to work with applicants (Q22), the level of effort and time involved in the permitting process(Q18, Q19), as well as the complexity and perceived technical competency of agencies (Q21, Q23) negatively affected the overall perception of the regulatory climate. It should be noted that nearly half of the respondents felt that there was no change in the level of effort (Q19), regulatory options (Q20), complexity (Q21), or technical competence (Q23), so these positive and negative perceptions are slight. It is also important to note that nearly half of the respondents were from agencies. It is unclear if or how responses to these questions differ among subsectors of respondents, but future questionnaire evaluations should evaluate results by sector or subgroups of sectors.

Table 8.9 Summary statistics for each question asked in the regulatory climate section of the survey. Percentage of respondents that selected each categorical response are noted in columns 3-7: SI=substantially increased, MI=moderately increased, NC=not changed, MD=moderately decreased, and SD=substantially decreased. Means (column 8) were calculated based on the method described in Section 8.2, and reflect the average score among respondents per question, which is translated back to a categorical response in the last column (9). Coloration reflects increases (dark and light green), no change (white), and decreases (light and dark red).

#	Regulatory Climate Questions: Since 2017,	SI (%)	MI (%)	NC (%)	MD (%)	SD (%)	Mean	Categorical Translation
18	The amount of time to complete the permit process has ____.	13.04	30.43	40.58	25.94	0.00	2.59	MI*
19	The change in level of effort and associated costs of acquiring permits has ____.	18.18	25.76	48.48	6.06	1.52	2.47	MI*
20	The regulatory options for permitting a project have ____.	5.88	39.71	47.06	5.88	1.47	3.43	MI
21	The complexity of the permitting process has ____.	9.09	31.82	54.55	3.03	1.25	2.56	MI*
22	The general willingness of agencies to work with the applicant has ____.	4.35	47.83	34.78	11.59	1.45	3.42	MI
23	The perception of technical competence within permitting agencies has ____.	1.45	21.74	47.83	20.29	8.70	2.87	MD
					Overall Categorical Result		2.89	MD

Interestingly, the majority of respondents (52.18%, Q22) indicated an increase in the general willingness of agencies to work with applicants. This is an intriguing point to consider in discussions of the permitting process as a whole and how it can be improved. With regard to funding, the permitting sector of the restoration process has not been allocated funds in the same regard as other sectors, like installation, over the last 5 years. So while costs have increased to obtain permits (i.e., increased time requirements), fewer funds have been allocated to managers for this process. If additional funds were allocated towards the regulatory process, agencies would theoretically be able to invest in improving the efficiencies of their offices, such as: additional training, additional hiring to avoid long approval times, higher pay for tenured personnel to better incentivize these employees to remain in important positions where staff is needed, and better employment benefits to attract new hires. Because respondents indicated on average that there has been a moderate increase in cost, effort, and complexity, it has likely become frustrating that the process has not gotten easier or smoother, only more expensive. However, because a majority of respondents indicated an increase in agencies' willingness to work with applicants, it is possible that some stakeholders are experiencing improved relationships with regulatory personnel, which could be helpful in the future in navigating rising direct and indirect costs.

Implementation (Q24-28)

Of note, question 28 was phrased so that an increase indicated a negative effect. To account for this in the mean calculation and overall interpretation, the categorical scores (i.e., SI =5, MI = 4, …., SD = 1) was reversed (e.g., SI = 1,…, SD = 5) for these questions(*).

Respondents conveyed an overall moderate increase in activities and qualities associated with restoration project implementation (Table 8.10). More than half the respondents perceived increases in the rate of implementation (50.72%, Q24), quality of projects (57.97%, Q25), the quantity that considers future changes in their design (76.47%, Q26), and the quantity aimed at testing new techniques (75.74%, Q27). Additionally, more than 65% of respondents perceived no change and ~24% of respondents indicated a moderate decrease associated with project failure or under-performance (Q28). This suggests that existing projects have generally been successful and that more restoration work has been accomplished in the Delaware Estuary over the last 5 years than prior to 2017.

The perceived increase in project quality since 2017 could be attributed to a few factors. Stakeholders in the Delaware Estuary indicated that in the last 5 years, there has been an increase in the trial of new techniques and applications in restoration projects. While there are always lessons learned when attempting new methods, the use of new technology or different procedures could be heightening project quality due to better efficiency or could be more cost-effective if these technologies save time, resources, or labor. Given this, managers attempting new techniques in their restoration projects should provide updates on the success of a new method and how it affected their project(s) at meetings with partners or by presenting results at conferences. Given that 76% of respondents indicated a perception of increased consideration of future conditions like sea level rise and habitat transgression in project development, these components should be at the forefront of long-term restoration work. A heightened consideration of future conditions implies that restoration work could provide managers with the potential opportunity to save money and time in future restoration considerations.

Monitoring (Q29-34)

Respondent responses indicated metrics associated with monitoring are trending in a positive direction (Table 8.11). More than 70% of respondents felt that the availability of project monitoring guidance (Q31) and the understanding of the effects of restoration projects as a result of monitoring (Q34) had increased. Although there were indications of moderate increases on average, between 50%-60% of respondents felt there had been no change in optional (Q29) or required (Q30) monitoring activities, as well as standardization (Q32) or funding (Q33) of monitoring activities.

The overall moderate increase with approximately half of respondents indicating no change in standardization of monitoring is interesting. There have been standardized monitoring guidance documents available in NJ and DE since 2017, which many of the respondents of this questionnaire contributed to or reviewed. It's possible that only those who participated in the creation of the documents actually use them, and expanded promotion may facilitate further standardization. But this has apparently not reduced the perception of understanding that monitoring provides, and that increases in funding paired with regulatory requirements may further support greater standardization, but a prescription to specific metrics and methods needs to be considered carefully.

Table 8.10 Summary statistics for each question asked in the implementation section of the survey. Percentage of respondents that selected each categorical response are noted in columns 3-7: SI=substantially increased, MI=moderately increased, NC=not changed, MD=moderately decreased, and SD=substantially decreased. Means (column 8) were calculated based on the method described in Section 8.4.1, and reflect the average score among respondents per question, which is translated back to a categorical response in the last column (9). Coloration reflects increases (dark and light green), no change (white), and decreases (light and dark red).

#	Implementation Questions: Since 2017,	SI (%)	MI (%)	NC (%)	MD (%)	SD (%)	Mean	Categorical Translation
24	The rate of individual project implementation has ____.	10.14	40.58	34.78	11.59	2.90	3.43	MI
25	The average quality of implemented projects has ____.	7.25	50.72	37.68	4.35	0.00	3.61	MI
26	The quantity of implemented restoration projects (e.g., sea-level rise, habitat transgression) that consider a change in future conditions rather than immediate conditions alone has ____.	16.18	60.29	20.59	2.94	0.00	3.90	MI
27	The quantity of implemented projects aimed at testing new techniques or applications has ____.	11.45	64.29	21.43	2.86	0.00	3.84	MI
28	The percentage of failures or underperformance associated with implemented projects has ____.	1.49	8.96	65.67	23.88	0.00	3.12	MD*
					Overall Categorical Result		3.58	MI

Outreach (Q35-40)

More than 80% of respondents felt that information regarding restoration needs (Q35), activities (Q36), and positive outcomes (Q37) has increased since 2017. More than half of the respondents felt that messaging clarity has increased (59%, Q40), and ~50% perceived no change in outreach regarding negative lessons learned (Q38) and messaging consistency (Q39, Table 8.12). Overall, these results indicate that outreach has been moderately increasing since 2017 in multiple areas. These positive results regarding messaging are encouraging but there may be an issue regarding communicating the negative (i.e., project "failure") restoration lessons learned/results. This is fundamentally one of the most important aspects to advance the practices of restoration but also represents one of the hardest aspects for practitioners to be open about and discuss openly. Part of this may be due to a need to show positive results, as negative bias can skew the perception of effectiveness. For example, multiple positive outcomes may be overshadowed by a single negative result; therefore, outreach focuses on the positives rather than the negative. Further conversation in appropriate language to discuss "failure" is needed, as well as the proper way for these to be communicated.

Table 8.11 Summary statistics for each question asked in the implementation section of the survey. Percentage of respondents that selected each categorical response are noted in columns 3-7: SI=substantially increased, MI=moderately increased, NC=not changed, MD=moderately decreased, and SD=substantially decreased. Means (column 8) were calculated based on the method described in Section 8.2, and reflect the average score among respondents per question, which is translated back to a categorical response in the last column (9). Coloration reflects increases (dark and light green), no change (white), and decreases (light and dark red).

#	Monitoring Questions: Since 2017,	SI (%)	MI (%)	NC (%)	MD (%)	SD (%)	Mean	Categorical Translation
29	Optional project monitoring has ____.	5.71	32.86	51.43	8.57	1.43	3.32	MI
30	Regulatory monitoring requirements have ____.	2.94	38.24	55.88	2.94	0.00	3.41	MI
31	The availability of project monitoring guidance has ____.	23.19	49.28	23.19	4.35	0.00	3.91	MI
32	Standardization of project monitoring across projects has ____.	8.70	37.68	53.62	0.00	0.00	3.55	MI
33	Funding for monitoring has ____.	0.00	27.54	59.42	11.59	1.45	3.13	MI
34	Understanding of effects of restoration projects as the result of monitoring has ____.	31.43	40.00	28.57	0.00	0.00	4.03	SI
						Overall Categorical Result	3.56	MI

Additional Questions

Respondents felt that installation receives the greatest amount of funding allocation (65%), while the next highest response was project design which received 13.64% (Q41) (Fig 8.10). The majority of respondents (74%) indicated that they receive most of their information about restoration topics via work group and committee discussions and/or presentations, such as in meetings (Fig 8.10). Only 8% of respondents said they receive information through peer-reviewed journals, which represents the "established" or "accepted" means of knowledge transfer, and no one said they received this information from tabling/outreach events (Fig 8.10). This is likely due to the sampling pool not being the target audience of these events and being on the "inside" regarding information sharing (Q42). When asked what the best method for absorbing information about restoration activities were, the majority of respondents selected the site visit/field trip option (34%), followed by work groups (30%) and conferences (17%, Q43) (Fig 8.10). Interestingly, although work groups and conferences were identified as the primary sources of receiving information regarding restoration activities, that site visits ranked higher for information absorption show the essential, valuable nature of these activities are still seen by the stakeholders as a very important means of absorbing information (Q43) (Fig 8.10).

The majority of respondents (71%) selected that only some of the requirements involved in the regulatory process seem appropriate while others only seemed appropriate to be of interest only to the permitting agency. Traditionally, agencies focused on performance-based monitoring for the purpose of determining if the proposed project successfully resulted in the establishment or enhancement of a specific resource type and provided the associated expected functions. The responses to this question suggest that regulatory requirements are going beyond this fundamental purpose for monitoring and heading more toward special interests or perhaps more research-related interests. Of interest is why this trend is occurring. Is it a result of lost institutional knowledge, new innovations, or one or more other reasons? Also, how are the additional monitoring requirements burdening the permitted project? However, 20% of respondents indicated that their perception of requirements is generally appropriate for their projects, so more discussion regarding regulatory monitoring requirements is warranted.

Table 8.12 Summary statistics for each question asked in the outreach section of the survey. Percentage of respondents that selected each categorical response are noted in columns 3-7: SI=substantially increased, MI=moderately increased, NC=not changed, MD=moderately decreased, and SD=substantially decreased. Means (column 8) were calculated based on the method described in Section 8.2, and reflect the average score among respondents per question, which is translated back to a categorical response in the last column (9). Coloration reflects increases (dark and light green), no change (white), and decreases (light and dark red).

#	Outreach Questions: Since 2017,	SI (%)	MI (%)	NC (%)	MD (%)	SD (%)	Mean	Categorical Translation
35	Information being relayed to stakeholders regarding restoration needs has ____.	15.94	68.12	14.49	1.45	0.00	3.99	MI
36	Information being relayed to stakeholders regarding restoration activities has ____.	17.65	63.24	17.65	1.47	0.00	3.97	MI
37	Information being relayed to stakeholders regarding positive restoration lessons learned/results has ____.	15.94	68.12	13.04	2.90	0.00	3.97	MI
38	Information being relayed to stakeholders regarding negative (i.e., project “failure”) restoration lessons learned/results has ____.	4.35	34.78	53.62	5.80	1.45	3.34	MI
39	The consistency in outreach messaging (e.g. what has been working, costs, feasibility of techniques) regarding restoration needs, activities, and/or results has ____.	5.88	36.76	54.41	2.94	0.00	3.46	MI
40	The clarity in outreach messaging has ____.	10.29	48.53	35.29	5.88	0.00	3.63	MI
					Overall Categorical Result		3.73	MI

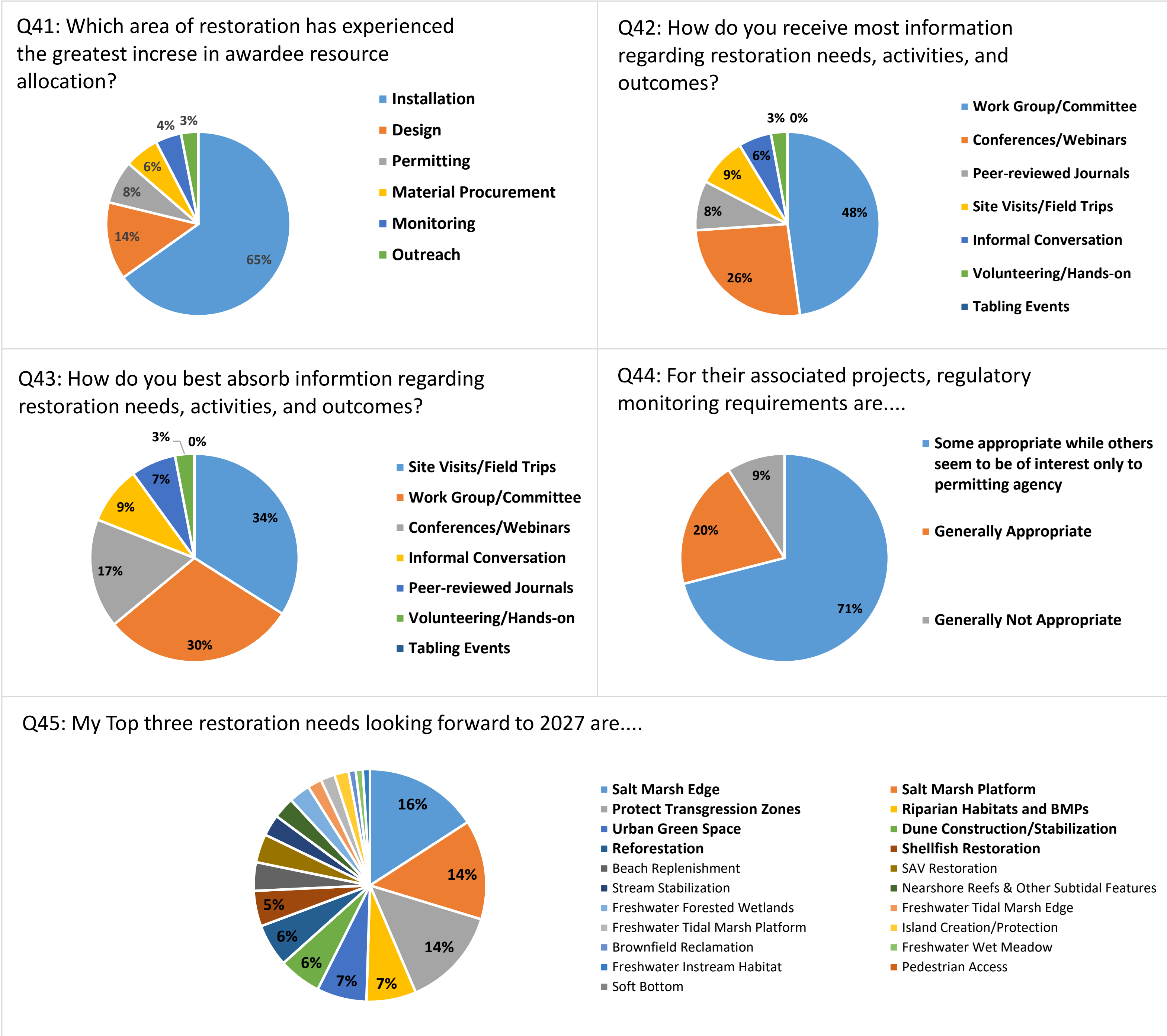

Figure 8.10 Summary of responses from additional non-physical questions.

The top three restoration needs looking forward to 2027 as selected by questionnaire respondents were salt marsh edge (16%), salt marsh platform (14%), and the protection of transgression zones (14%, Q45). These topics are common in many regional restoration work groups but may reflect the imbalance of the questionnaire respondents. However, Q4 indicated that the most common area of restoration that respondents worked in were upland habitats and freshwater tidal habitats. Thus, these results suggest somewhat of a consensus among restoration practitioners of varietal backgrounds and expertise that these three priorities are currently the most important across the field. Additionally, each agency and NGO has a unique mission or programmatic goal for one or multiple natural resources. Laws, regulations, policies, programmatic management plans, and precedence control how an entity applies its mission and goals toward innovative technology. Because of this dynamic, it is not uncommon for entities to have nonparallel views on certain applications of innovations. It often takes time, coordination, and teamwork between entities to sort out such inconsistencies. Given this, it is promising that respondents of different entities and backgrounds seem to agree on what needs to be prioritized in the restoration field.

Discussion

Moving Forward with Restoration Efforts in the Delaware Estuary

Overall, restoration activities have been increasing in the Delaware Estuary 2017-2021 relative to the 2006-2011 and 2012-2016 periods (Fig 8.4), largely focused on tidal wetlands, forests/woodland, agriculture, and beaches (Fig 8.7). Moving forward, the top identified needs for restoration in the estuary are the salt marsh edge, salt marsh platform, and transgression zones (Fig 8.10, Q45), despite the fact that the largest self-identified restoration focus areas by respondents were upland and tidal freshwater systems (Table 8.3). Additionally, the questionnaire suggests that the level of investment for restoration is trending in a positive direction, but uncertainties lie with the acquisition and distribution of funding, as well as the matching funds' requirements (Fig 8.11, Table 8.8). Future efforts should include simplifying the grant application process and finding additional means to get funding to both the larger and smaller restoration entities, while either reducing the match requirements or broadening the range of qualifying funds.

There has been a hard push towards innovation by a small nucleus of practitioners. There appears to be a call for further increases in innovation by stakeholders; however, many current issues make innovation difficult, including the costs and complexity of acquiring permits as well as acquiring funding for those innovations (Tables 8.8, 8.9). Yet, stakeholders felt that there was a willingness of regulatory agents to work with application and support innovation (Tables 8.7, 8.9). Innovation can be complicated and often site-specific. A successful innovative project is often copied. For example, if the new user of the technology does not fully understand the use of the innovation, negative consequences or under-achievement of outcomes may occur. As such, information transfer between entities is essential to maximize the continued success of innovation. Despite these variations in conception in practitioners, innovation still scored well indicating a general feeling that the opportunity and momentum are in place to move forward if challenges in funding and permitting can be overcome (Table 8.7)

Perception of regulatory climate is the only clearly under-performing metric (Figure 8.11, Table 8.9). There has been limited change in restoration project regulations over the past five years, other than the development of new general permits; otherwise, costs have increased, and obtaining permits has become more arduous (Table 8.9). This may have caused project managers to feel inclined to adjust the scopes of future projects to make them more narrow (or aligned with more commonly accepted practices or scales) to counteract high permitting pricing or to avoid unnecessary requirements of permitting agencies. If this were to occur, other aspects of restoration project management would be impacted, and may lead to more conservative restoration work in the Delaware Estuary rather than projects developing that are expansive and growing. Moreover, if project managers are not capable of or are unable to oversee cost increases for the same procedures, it could contribute to fewer projects being implemented and a generally less efficient regulatory process. Relatedly, a smaller subset (20%) of questionnaire respondents reported that they felt regulatory monitoring requirements were generally appropriate for their associated projects (Fig 8.10, Q44). Conversely, 71% of respondents felt that while some requirements are sometimes appropriate, other times these requirements only seem to be of interest to the permitting agency. This trend could be viewed in several different ways, depending on the role of the agency. It may represent a loss of institutional knowledge within regulatory programs as a result of personnel turnover, with hefty responsibility placed on new staff. It could also represent a disconnect between regulatory requirements, and the rapidly advancing suite of tools and methodologies employed by practitioners.

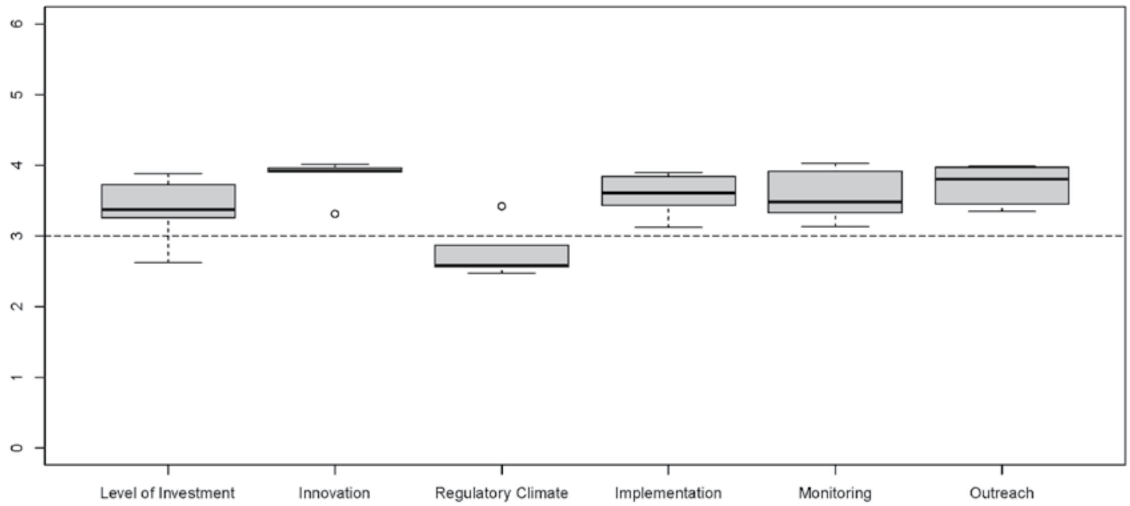

Figure 8.11 Boxplot of average responses to questions regarding each metric in the restoration survey. All metrics other than Regulatory Climate had an average response of Moderately Increased or greater for each survey question.

While costs have risen and general permits are developing, the main change in the regulatory climate over the past 5 years has been the turnover of personnel. This has resulted in the net loss of experience, institutional knowledge, further innovation, and other technological advancement abilities. Thus, there is a need for outreach education and experiences for the regulatory community, including middle management. As such, regulatory climate is linked to outreach in that outreach needs to create a focus on agency-targeted workshops and partnerships. To date, outreach has been consistently focused on external stakeholders (e.g., the general public), but outreach for internal personnel would also be beneficial. A key way to implement change in the restoration field will be to refocus some outreach towards practitioners and new agency individuals, as this will be integral to improving the overall regulatory climate, better allocation of funds, more easily identifying gaps, and improving project efficiency.

Additionally, the current status of outreach in the restoration field presents a huge bias in considering positive results and shying away from negative results. Negative outcomes as a result of learning are important to consider when implementing new policies and management techniques; however, positive outcomes protect methodology, so when results are positive, general stakeholders don't hear about any drawbacks concluded from results and therefore skew willingness to continue to learn, and potentially inhibit the ability or opportunity to secure funding in the future to continue learning new lessons relative to the restoration field.

Monitoring is a key component in advancing restoration practice and assessing the effectiveness of cutting-edge innovation. Unfortunately, maximizing monitoring efforts is becoming increasingly difficult due to the increased scope of investigation, regulatory requirements, and pressures of optimizing funding to get the most acres/miles of restoration completed. As many agency partners are unable to provide funding for monitoring, and since most budgets have been finalized long before regulatory requirements are known, the restoration community needs to become more adept in building a baseline and post-construction monitoring costs into initial project scopes, increasing efficiencies and regulatory assurance. Moreover, investment results evaluated through monitoring can support arguments for increased funding for monitoring in years to come.

The collection and assimilation of monitoring data lead to the refinement of methodologies and practices, which provide ecological and institutional benefits. Lessons learned enable the evolution of practices and, in some cases, transferability. One consistent issue is the comparative disparity in monitoring between more established and well-funded programs/projects and smaller grass roots or community-based efforts. Smaller project partners usually have a tighter budget and may not be able to implement a full suite of monitoring protocols that regulatory agencies normally require or expect with better-funded projects. The lack of scaling regarding requirements and methodologies creates a burden of these efforts that may diminish project size below the thresholds necessary for effectiveness. Successful landscape-level restoration efforts will be the result of a synergy between community-driven, grassroots efforts, and larger-partnered planning efforts. Growth of practices, innovation, expanding knowledge of the importance of ecosystems in communities, and why conservation and restoration practices are important all need to work in conjunction at the time of project implementation. A lack of experience and scientific knowledge across the regulatory community, grant reviewers, and partners has led to the juxtaposition of equity in restoration and understanding of how scientific knowledge is gained and utilized. We need advancements in scientific knowledge, especially with emerging issues (e.g. geochemistry in elevation enhancement projects, wave attenuation, climate change feedback, over-engineering, "soft engineering", etc.), but not at the expense of community and civic engagement-led restoration. Scaling of requirements and methodologies, paired with a better understanding of the value of qualitative monitoring can help us achieve more equitable outcomes. In some cases, a photo time series can provide as much understanding of a project's outcomes and its impact on a community as more precise metrics, depending on the goals of the effort.

As restoration practitioners and the supporting community work to advance practices, it needs to be recognized that as a whole we are lagging behind in our responses and scaling in restoration with response to climate change and relative sea level rise. The observed losses of vegetated tidal habitat due to sea level rise and anthropogenic-induced disequilibrium have resulted in extreme variations in wetland conditions across the watershed. "Hotspots' of wetland loss and/or decreased wetland function illustrate the need to increase the scale (spatial size) and the rate at which wetland restoration projects are conducted. The annual rate of restoration (i.e., acres and the number of projects) should outpace the average annual losses, but this is currently not the case. The losses of coastal habitat have been recognized and monitored for decades, but the effects of anthropogenic pressures have brought to light the true magnitude of the decoupled nature of the evolution of these aquatic and coastal systems with the rate of sea level rise and changes in the distribution of sediments within the system. Loss of habitat function and spatial distribution mark an increase in the number of obligate species that are imperiled as climate change, sea level rise, and anthropogenic impingement shrink the ecosystem landscape. Restoration is not an immediate process or cure for the ails of the systems as there is a lag in the restored function which can vary significantly between habitat types and biotic communities. The lack of large-scale (i.e., larger footprint and total area) restoration, especially in tidal marshes, indicates that the restored areas that will anchor the habitats for impaired species 3 to 10 years from now should already have been restored or been in the process of being implemented.

Demonstration projects are necessary to exemplify the effectiveness of practices to resource managers and regulatory agencies, but there is a lack of urgency in moving these demonstration projects to the appropriate scale for landscape-level effects. A mosaic of small projects can be effective in some habitat types and locations (especially in urbanized landscapes) but it is understood that generally larger patches and connected habitats (corridors) create a better mosaic that is ultimately needed in the estuary. A collection of smaller patches' habitat function is lower than that of a larger continuous block, as there is not a linear relationship between discrete blocks to continuous patches in ecological function. Large blocks or patches are more desirable as they inherently have higher resilience and ability to ecologically and spatially adapt to changes in their base-level and abiotic drivers. Climate change is affecting the entire region, and our restoration focus needs to have that same corresponding attention. Larger connected projects on the wider landscape are needed, but there are concerns regarding transferability that may slow larger intervention efforts.

Significant differences in how restoration practices and scales should be implemented on the landscape exist between states, counties, and federal agencies. There will be hesitancy in implementing innovative or larger-scale projects, as the fear of failure can dampen risk-averse entities' enthusiasm for supporting these types of projects. Questionnaire respondents indicated that the percentage of implemented projects that have failed or underperformed has moderately decreased in the last 5 years, but this may be to more conservative goal alignment rather than full intervention success so this concern is still valid among practitioners (Table 8.10). The transferability of project design themes, specifications, and methods from one state or organization to another, or outside the region, is recognized as a major issue that is impeding the expansion of implementation and increasing project size. Successful projects and practices outside the region need to be effectively integrated into the restoration community toolbox if future goals and objectives to combat climate change are expected to be achieved. Leveraging partners' lessons learned and experiences is a fundamental necessity that needs to be addressed for the restoration community and has to be a focal point for future investment in the communities' resources.

The future of restoration needs to be aligned around a focus on ecosystem-scale function, and not solely focus on habitat- or species-specific goals. We have learned that restoration projects that take an ecosystem approach tend to be more resilient and establish a better baseline for future natural evolution as they provide more opportunities for spatial ecological response. Anthropogenic influences have decoupled their natural evolution and we need to ameliorate these mistakes, and potentially erroneous management actions, by restoring the foundational physical aspects of the coastal systems (i.e., hydrology, elevation, etc.). An ecosystem approach on a larger area (on a basin or drainage area landscape) incorporating abiotic and biotic feedback, supports greater resilience for species and people through a wider variety of associated benefits (e.g., flood attenuation, nutrient removal, wildlife-dependent activities). Despite the rapid evolution of the landscape and its habitats due to climate change and human use, the natural resources community often becomes entrenched in static views and ideas of what the landscape setting and evolution will soon look like. For example, not all erosion is bad, beaches do not belong everywhere, and some locational appropriateness can change over time with regard to restoration in the Estuary. Becoming comfortable with natural processes rather than imposing an ideological will may be the result of a cultivated idea or generally, the right decision made for a certain site or area. Not working on something that may be impacted by natural processes is not necessarily a lack of action being taken.

Recommendations

- Salt marsh edge stabilization, salt marsh platform elevation enhancement, and protection of transgression zones were identified as the top three necessities for restoration in the next five years (Fig 8.10) and should be prioritized moving forward. A need for some kind of increase in consideration of future conditions in project development was also identified, potentially including any or all of these top 3 considerations, despite questionnaire respondents representing different entities and aspects of the restoration field.

- Innovation is generally increasing (Table 8.7), but specific regulatory pathways for innovative tactics, possibly with more rigorous monitoring requirements to broaden restoration implementation knowledge, may facilitate further tactic development to meet changing spatial and ecological restoration needs.

- The funding process should have a simplified grant application process and find additional means to get funding to a diversity of restoration entities spanning a range of entity types and sizes. A scaled process that encourages entities that do not have larger capacities and experiences would greatly expand the work to the smaller community level which would be better implemented in communities that have not been engaged and create better "buy-in" by implementing self-identified community projects.

- Although there is a general increase in the costs, effort, and complexity of the regulatory process, there is also a perceived increase in the willingness of regulatory agencies to work with applicants (Table 8.9), indicating the potential for the development of cross-disciplinary relationships. It is important to keep relationship development moving in a positive direction, especially with newer agents, as these relationships may be a source of future modifications to ease the regulatory process for innovation and shortened timelines.

- Information on new technologies should continue to be shared in the restoration community to allow for continued development and refinement of new methods and techniques and avoid misunderstanding the use of new tools. The means by which this knowledge sharing should be implemented is unclear, but will always be rooted in formal and informal communication, and anchored in field-based knowledge transfers with constant and consistent communication between the restoration and the regulatory communities.

- The restoration community generally feels that project monitoring (required and optional) has been increasing (Table 8.11), but almost 60% of those polled indicated that there has not been any change in the standardization of monitoring methodologies, despite the development of a restoration monitoring framework in 2016 (Yepsen et al. 2016) developed by a multi-sector panel. Greater effort should be made to promote the existing monitoring documents, with periodic revisions to integrate new metrics and methods.

- Connecting related projects together on a wider spatial scale will assist in reaching restoration targets. Project teams including partners of various sizes with varying levels of project experience to tackle larger restoration objectives could facilitate more effective implementation with more thorough community representation. Restoration entities should maintain communication to better understand the results of implementation at multiple scales to design more comprehensive and effective projects.

- The restoration community needs to continue conveying negative outcomes of restoration efforts (Table 8.12), framed not as failures, but as key steps in a scientific inquiry process aimed at moving effective restoration practices forward. These appropriately framed results can help showcase how innovation, even if unsuccessful in meeting project-specific goals, can be successful in narrowing the focus of tactic development towards what works rather than burring these outcomes in fear of negative perception resulting in potential reapplication.

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Appendix 8.A: Stakeholder Questionnaire

Introduction

Thank you for taking the time to take the Partnership for the Delaware Estuary's 2021 questionnaire regarding non-physical influences on restoration practices in the Delaware Estuary. Your answers to the following questions will be used to develop the Restoration chapter of the Delaware Estuary Program 2022 Technical Report for the Estuary and Basin (TREB). The purpose of the TREB is to assess the overall environmental condition of the watershed by examining the status and trends of key indicators that reflect the health of its natural systems. The TREB is produced every five years, with the last publication in 2017. The Restoration chapter was first introduced in 2017 with the objective to provide information on restoration efforts and progress. As restoration practices are influenced by many factors other than the implementation efforts themselves, this questionnaire is designed to gather information on some of those factors that are not frequently evaluated. You have been selected as a prospective participant due to your expertise and experience in local and/or regional restoration activities. This questionnaire should not take more than 30 minutes, and all input and communication will be kept confidential unless otherwise permitted. If you have any question, comments, or concerns, please reach out to Joshua Moody, PDE's Restoration Programs Manager at jmoody@delawareestuary.org

Section 1: Respondent Description

Please let us know a little about yourself. Name is not required, but please fill out the other sections to the best of your ability. Answers to these questions will be used to partition data and contextualize summary statistics to identify overarching factors that contribute to particular perspectives and experiences.

1. Name (not required)

2. Sector

- Federal
- State
- Private
- Academic
- NGO
- Other

3. How many years have you been involved in restoration in the Mid-Atlantic?

- 0 to 3 Years
- 3 to 5 Years (i.e., since 2017)
- 5 to 10 years
- 10 to 20 years
- 20 to 30 years
- 30+ years

4. Typical Working Habitat (choose up to three)

- Upland
- Tidal Freshwater

- Tidal Brackish/Saltwater
- Non-Tidal Freshwater
- All of the above
- Other

5. What area of restoration practice are you typically involved in (choose all that apply)?

- Distributing Funds
- Site Evaluations
- Project design
- Permitting
- Installation
- Monitoring
- Training
- Outreach
- Regulating
- Other

6. Is your organization a Delaware Estuary Program (DELEP) partner or a member of any DELEP committees? DELEP partners are a group of regional organizations that, with PDE, work together to coordinate and implement long-term plans for the Delaware Estuary. DELEP committees include the Steering Committee, Estuary Implementation Committee (EIC), and the Science and Technical Advisory Committee (STAC).

- Yes
- No

7. Has your organization partnered on restoration projects with PDE?

- Yes
- No

Section 2: Categorical Questions

Please select a response from the provided options to the statements in the following six categories from the list of options provided for each that is most reflective of your experience and understanding. Generally, the answers will follow a pattern of declining agreement, including a neutral option as follows:

- Substantially increased
- Moderately increased
- Not changed
- Moderately decreased
- Substantially decreased

Please answer all questions by considering the time frame 2017-2021 in the Delaware Estuary.

Innovation: Innovation is the development of new ideas and approaches or new applications of existing ideas and approaches. Innovation can be applied to restoration techniques, technology, and/or tactic design or implementation. For each of the following questions, please select the answer most reflective of your experience.

1. Since 2017, the use of feedback, lessons-learned, and/or results to inform project design has____.
2. Since 2017, the general level of innovation applied by regional organizations has ________.
3. Since 2017, the level of innovation applied by the organization I represent has ________.
4. Since 2017, the proportion of new and proposed projects that incorporated (not just discussed) sea level rise into their design has______.
5. Since 2017, the effects or actions associated with the regulatory process have _______ the opportunity for the application of innovation.

Level of Investment: These questions ask the user to consider changes in factors related to funding opportunities for restoration efforts. For each of the following questions, please select the answer most reflective of your experience.

1. Since 2017, funding for restoration opportunities has______.
2. Since 2017, the proportion of available funding that is focused on implementation rather than project planning has______.
3. Since 2017, the proportion of available funding for project monitoring has______.
4. Since 2017, match requirements have ______ the level of difficulty in applying for funds.
5. SInce 2017, the distribution of funding across diverse recipients has ______.

Regulatory Climate: These questions ask the user to consider changes in regulatory considerations, requirements, and timeframes as they relate to restoration project implementation and requirements. For each of the following questions, please select the answer most reflective of your experience.

1. Since 2017, the time required to complete the permit process has______.
2. Since 2017, the level of effort and associated costs of acquiring permits ______.
3. Since 2017, the regulatory options for permitting a project have______.
4. Since 2017, the complexity of the permitting process has _______.
5. Since 2017, the general willingness of the agencies to work with the applicant has ________.
6. Since 2017, the general perception of technical competence within permitting agencies has _______.

Implementation: Implementation refers to the actual execution of restoration activities at a specific-location, such as construction, deployment of fill material, excavation, or any activity that alters or adds to the landscape. For each of the following questions, please select the answer most reflective of your experience.

1. Since 2017, the rate of individual project implementation has ______.
2. Since 2017, the average quality of implemented projects has ______.
3. Since 2017, the number of restoration projects implemented that consider a change in future conditions (e.g., sea level rise, habitat transgression) rather than just the immediate condition has ______.
4. Since 2017, the number of implemented projects aimed at testing new techniques or applications has ______.
5. Since 2017, the percent of failures or under performance associated with implemented projects has _______.

Monitoring: Monitoring refers to any activity conducted with the explicit intent to collect information related to any facet of the project that will be used to better understand one or more processes potentially affected by the restoration activity. This can include project monitoring conducted on consistent, sporadic, or opportunistic time frames, and for required (i.e., permit requirement) or optional (PI/partner initiated) activity. For each of the following questions, please select the answer most reflective of your experience.

1. Since 2017, optional project monitoring has ______.
2. Since 2017, regulatory monitoring requirements have ______.
3. Since 2017, the availability of project monitoring guidance materials has ______.
4. Since 2017, standardization of monitoring across projects has ______.
5. Since 2017, funding for monitoring has ______.
6. Since 2017, monitoring has ________ my understanding of restoration.

Outreach: Outreach refers to activities intended to disseminate information regarding restoration needs, activities, and/or results to any stakeholder (e.g., different sectors, general public, educators, other practitioners). For each of the following questions, please select the answer most reflective of your experience.

1. Since 2017, information being relayed to stakeholders regarding restoration needs has ______.
2. Since 2017, information being relayed to stakeholders regarding restoration activities has ______.
3. Since 2017, information being relayed to stakeholders regarding positive restoration lessons learned/results has ______.
4. Since 2017, information being relayed to stakeholders regarding negative (i.e., project "failure") restoration lessons learned/results has ______.
5. Since 2017, the consistency in outreach messaging (e.g. what has been working, costs, feasibility of techniques) regarding restoration needs, activities, and/or results has ______.
6. Since 2017, the clarity in outreach messaging has ______.

Section 3: Additional Questions

Please select one response from the provided options to the questions below that is most reflective of your experience and understanding.

1. Since 2017, which area of restoration has experienced the greatest increase in awardee resource allocation?

- Design
- Permitting
- Material Procurement
- Installation (material installation costs and associated labor)
- Monitoring
- Outreach

2. How do you receive most of your information regarding restoration needs, activities, and outcomes/lessons learned?

- Peer-reviewed Journal Articles
- Presentations at Conferences or on Webinars
- Work Group/Committee Discussion and/or Presentations
- Site Visits/Field Trips
- Tabling/Outreach/Education Events

- Informal Conversation
- Volunteering/Hands-on Experience

3. How do you best absorb information regarding restoration needs, activities, and outcomes/lessons learned?

- Peer-reviewed Journal Articles
- Presentations at Conferences or on Webinars
- Work Group/Committee Discussion and/or Presentations
- Site Visits/Field Trips
- Tabling/Outreach/Education Events
- Informal Conversation
- Volunteering/Hands-on Experience

4. Which statement best reflects your thoughts on regulatory monitoring requirements:

- They are generally appropriate for their associated projects.
- They are generally not appropriate for their associated projects
- Some are appropriate while others seem to be of interest only to the permitting agency.

5. Looking forward to 2027, where do you see the biggest restoration need (select your top three)?

- Salt marsh edge stabilization
- Freshwater tidal marsh edge stabilization
- Salt marsh platform elevation enhancement
- Freshwater tidal marsh platform elevation enhancement
- Dune construction and stabilization
- Beach replenishment
- Protection of transgression zones (e.g., for forests, wetlands)
- Shellfish restoration (across salinity gradient)
- Stream stabilization
- Island Creation/Protection
- SAV Restoration
- Soft Bottom Habitat
- Reforestation
- Freshwater Wet Meadow
- Freshwater Forested Wetlands
- Freshwater Instream Habitat
- Riparian Habitats and BMPs
- Urban Greenspace Reclamation
- Brownfield Reclamation
- Pedestrian Access