ANALYSIS OF OYSTER RESTORATION POLICY AND PRACTITIONER FEEDBACK IN THE HUDSON-RARITAN ESTUARY

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Executive Summary

New York and New Jersey share a body of water in the form of the Hudson-Raritan Estuary (HRE), which extends from Sandy Hook, NJ, to Ossining, NY. The HRE is the historic home of the native Eastern oyster (*Crassostrea virginica*), which was once the predominant substrate in the New York Harbor and surrounding areas but now is considered ecologically extinct. Oysters were also an extremely common food source throughout history and were enjoyed by many as New York City's population began to boom in the 1800s. Along with the population came pollution, and the combination of overharvesting and poor water quality lead to a crash in the oyster population. Now, the HRE has the best water quality that it has seen in many decades, and with that there is an increased push for oyster restoration. Oysters provide ample ecosystem services and ecological benefits, so restoring their population in this waterway is a priority for multiple organizations. However, policy can be very strict around oyster restoration due to the risk of poisonings that may occur if humans were to illegally harvest from these restoration projects. New York and New Jersey's policies approach restoration differently because of these concerns, and there has been some conflict between regulating agencies and restoration practitioners because of these concerns in the last decade. As such, this project sets out to answer the questions: 1) What are the main differences in oyster restoration policy between New York and New Jersey?; 2) How do the differences in policy affect applied restoration in each state?; and 3) What policy changes could be implemented to help the water quality/environmental balance, as well as the overall balance of the restoration efforts in HRE waters?

In order to address these questions, policy research was carried out to ultimately inform semi-structured interviews with restoration experts and practitioners working in the HRE. Interviewees were asked questions surrounding their experiences with policy, barriers to their work, changes that could affect their ability to do work, and their experiences with poachers. The results demonstrated that restoration policy is stricter in New Jersey, where regulators tend not to permit any projects proposed in waters classified as "closed". In New York, restoration projects in closed waters are much more common, although regulators still heavily prioritize preventing illegal harvesting of oysters. In both states, personal relationships with regulators and incorporating feedback from early in the project planning process helped develop restoration efforts that were feasible, scientifically valid, and safe for regulators to approve. Practitioners

from both states reported a lack of policy that is specific to the needs of restoration, stating that they were commonly required to work within the bounds of indirectly related policies such as waterfront development rules. Experts from both states also highlighted that state regulatory agencies bear requirements to an FDA federal shellfish program, which requires them to report on their own monitoring of sites. Due to a lack the inspection staff, regulators may be limited in their ability to approve more sites. Many practitioners also emphasized that there appears to be an attitude of growth moving forward and a shared goal amongst regulators and practitioners to achieve restoration in the future, especially in New York waters.

Based on these findings, the following recommendations were proposed.

1) Increase the number of staff at regulatory agencies that may conduct site monitoring and inspections.
    a. This recommendation is aimed at state regulators. This is a short-term goal that will be essential in order to reach restoration targets that have been set by the state. Both NY and NJ have recently identified funding for environmental jobs, and as such creating new openings in the DEC and DEP should be economically feasible.
2) Develop a recurring workshop, webinar, conference, or other engagement event.
    a. This recommendation is aimed toward restoration practitioners as a medium-term goal to implement recurringly in coming years. A workshop, especially if well attended by regulators and local restoration organizations, could help garner strong relationships between groups. It could also be a valuable space to share data, project progress, best practices, and other annual updates that could facilitate restoration success.
3) Support more reef potential projects.
    a. This recommendation is aimed at both practitioners and regulators. This medium-term goal could help create scientific data supporting the presence of a self-sustaining wild population, something that many practitioners cited as lacking. It may also be easier to gain approval for these projects, due to the lack of market-size oysters, and would remove financial costs associated with larval seeding and other early-stage processes.
4) Change in Policy
    a. This is a long-term goal for restoration practitioners and regulators to collaborate on. Specific policy relevant to restoration is necessary to bolster future work and create meaningful restoration in the HRE.

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Introduction

History

The Hudson-Raritan Estuary (HRE) is a body of water adjacent to New York and New Jersey that extends from the Hudson River and includes the Raritan Bay, Sandy Hook Bay, parts of the Long Island Sound, and the nearby brackish estuarine wetlands, rivers, and shorelines (O'Neil *et al*., 2016). Many of areas within the HRE could support the restoration of the native Eastern oyster, *Crassostrea virginica.* The Eastern oyster has a long history in the natural environment surrounding New York and New Jersey, where it historically occurred from Sandy Hook, New Jersey, to Ossining, New York as its Northern reach (Franz 1982).

Prior to European colonization in the 1600s, oysters were the predominant bottom substrate in the New York Harbor, and were a staple food source for the Lenape and Canarsie indigenous peoples that resided in the area (McCann 2019). European settlers in what is now New York City overexploited oysters as a food source, and they sold in massive quantities at low prices throughout New York and the surrounding areas (Franz 1982). Early New Yorkers ate oysters in such abundance that by 1658, the New Amsterdam Dutch Council limited the quantity and harvesting areas from which oysters could be gathered to address the ongoing overharvesting (Nigro 2011). Oyster populations were beginning to noticeably dwindle by the 1800s and seed oysters had to be brought in from the Chesapeake Bay to supplement the wild population in the HRE (McCann 2019, Franz 1982). Near-constant dredging of the harbor to allow for continued industry damaged natural oyster habitat and led to further decline in the population of shellfish as New York City continued to urbanize and move further into the industrial era (Franz 1982).

The pollution into the HRE that occurred in the late 1800s and early 1900s lead to widespread outbreaks of typhoid fever in the early 1920s, which became associated with the consumption of unregulated, contaminated oysters (Holley 2018). The era that followed the early 1900s saw ample sewage and industrial pollution contaminating the New York Harbor, which further damaged the oyster population and made them unfit for consumption; by the 1920s, the New York Harbor's oyster beds were officially closed to harvest (McCann 2019). The last oyster bed was closed in 1927 due to toxicity of the shellfish product – the ultimate most highly contributing factor to oyster population loss was sewage contamination, which caused eutrophic, low oxygen conditions unfit for oyster growth (Nigro 2011, Franz 1982). Oyster reefs are no

longer a viable food source due to the water quality of the New York Harbor. Some of the main contaminants that oysters are unable to remove are polychlorinated biphenyls (PCBs) and heavy metals, including the 1.3 million pounds of PCBs that were added into the Hudson River by General Electric between 1940 and 1977 (US EPA 2022, Nigro 2011). These contaminants were found in dredged sediments in the mid-20th century, and will affect the overall water quality of the HRE for many years to come (O'Neil *et al.*, 2016). Since these closures and tipping points, many changes have been made to policy and regulations, which has had resounding positive effects on the water quality in the HRE since 1972 (Brosnan & O'Shea 1996, O'Neil *et al.,* 2016). The majority of the HRE oysters are highly unlikely to be suitable for consumption for hundreds of years, if ever; yet, it is still important to restore oyster populations for the other benefits that they provide.

Ecological Role

Oyster reefs have numerous benefits for coastal areas due to the ecosystem services that thriving reefs can contribute. They may serve as a protective measure to reduce damage from storm surge and high tides, as underwater oyster reefs may decrease the force of oncoming waves and buffer shorelines (Barbier 2017, Arkema *et al*., 2017). With enough strong and established reefs, this wave attenuation capacity could reduce financial costs associated with future storms and destructive hurricanes, if reefs reached a strong enough status (Arkema *et al*., 2017, Wakefield 2020). Low-lying areas like Manhattan and its surrounding metropolitan sprawl are likely be at-risk in the coming years as climate change and sea-level rise threaten shorelines (Rosenzweig *et al.*, 2011). Thus, planning to adapt for climate change is an ongoing effort in New York City and the nearby areas (NYC MOCEJ 2022, Wakefield 2020). Working to restore oysters as a nature-based adaptation solution has been a driving force behind some oyster restoration efforts in the last couple of decades and has potential as a resilience mechanism (Wakefield 2020).

In addition to the climate resiliency services that oyster reefs may provide to humans, they can also serve as a form of habitat. Oyster shell can host barnacles, sponges, tunicates, and bryozoans just on the shell substrate (Posey *et al*., 1999). Oyster reefs can also create habitat for intertidal species and nursery zones for fish that swim into the more protected harbor areas to spawn (McCann 2019). In the HRE, these species can include oyster toadfish, skilletfish,

blennies, blue crabs, black sea bass, and more (McCann 2019). There are more than twenty local species of fish that are recorded to be enhanced by oyster restoration living in the HRE (McCann 2019). By providing these ecosystem services, oysters support the growing ecological restoration of the harbor and help improve the biodiversity of the harbor area, especially insofar as other habitat appears to be lacking in the area. As more oysters there are restored to the HRE, there is greater hope for continued resurgence of native wildlife species that rely on healthy habitat to survive.

Another ecosystem service provided by oysters is water filtration. They are filter feeders, which means that as they have the ability to clean water as they eat by filtering out plankton and other suspended particles (Grizzle *et al*., 2008). Many bivalves are filter feeders, but oysters are commonly considered some of the most dramatically effective: an adult oyster can filter up to fifty gallons of water in a day (Grizzle *et al*., 2008). The mean size and density of reefs impacts the degree of particle removal effectiveness, which indicates that restored reefs may be able to provide water quality improvements quickly after their construction and installation (Grizzle *et al*., 2008). Oyster reefs have the ability to remove harmful pollutants including lead, mercury, and BPAs, which may become lodged in the tissues of the oyster (Mingoya 2014). They also take up nitrogen, which can help reverse some of the eutrophic conditions that affect the HRE due to overwhelming sewage pollution (Carmichael *et al*., 2012, Rice 2001).

Oysters' filter feeding capacity are a major factor as to why they are so highly controlled; due to their ability to process pollutants from the water, oysters may also accumulate pollutants in their tissues if the waters they reside in are contaminated (Faulkner 1961). It is a catch-22, in that filter feeders might be the most necessary in these contaminated waters, which stand to gain from regular filtration and removal of historically accumulated contaminants. This aspect of oysters' ecology contributes heavily to the policy controls that exist surrounding oyster growth and consumption, as it is extremely important to prevent illnesses and poisonings that can occur as a result of eating contaminated shellfish.

Not long ago, oysters were considered ecologically extinct in the ecosystem, and great efforts have been made to reintroduce the species (Ravit *et al*., 2012). Since the passage of the Clean Water Act in 1972, the water quality has greatly improved in the NJ/NY Harbor, and oyster populations have slowly begun to increase (Brosnan & O'Shea 1996). This is aided

greatly by efforts from a variety of organizations working to repopulate oysters in the region; however, differences in policy and permit accessibility mean that there may be an inequality in the extent of oyster restoration efforts occurring on the New Jersey side of the HRE as compared to the New York side. As climate change continues to impact the low-lying areas surrounding the New York Harbor, it is more urgent now than ever that oyster restoration efforts are being carried out effectively and on as great a scale as possible such that reefs can begin to establish themselves and buffer shorelines as a measure of climate adaptation.

Research Questions

In order to understand more about restoration policy and applied restoration in New York and New Jersey, I pose the following research questions:

1. What are the main differences in oyster restoration policy between New York and New Jersey?
2. How do the differences in policy affect applied restoration in each state?
3. What policy changes could be implemented to help the water quality/environmental balance, as well as the overall balance of the restoration efforts in HRE waters?

Methods:

For the policy overview and history portions of the research, I conducted online research of the New York Department of Environmental Protection (NYDEP) and New Jersey Department of Environmental Conservation (NJDEC) policies, as well as of federal guidelines and regulations. I attempted to thoroughly and comprehensively understand the requirements necessary to establish shellfish restoration activities in both states from publicly available resources. I also sought out to understand the history and purpose of oysters in the Hudson Raritan Estuary and the role that they play in that ecosystem.

For the interview portion of this project, I first applied for approval from the Institutional Review Board at Duke University to speak with subjects about the work they do in the field of oyster restoration. Once Institutional Review Board approval was secured for this project, these individuals were recruited through email or by connection through other interviewees ("snowball

sampling"), and they were found via online research of organizations that participate in restoration activities in NY and NJ. All individuals recruited either heavily participate in restoration from policy or applied research standpoints, work at organizations that heavily participate in restoration, have published work on the subject, or have a combination of these qualifications.

I spoke with seven people, all of whom were connected with at least one oyster restoration project in the Hudson Raritan Estuary by collaboration with either a non-profit, educational, or state institution. One of the interviewees was a state regulatory agent. All interviews were conducted on Zoom and recorded for later analysis. Interviews lasted anywhere from 30 minutes to an hour, and were semi-structured, such that individuals could answer questions in as much depth as they felt was necessary. Interview questions varied slightly based on interviewee expertise.

I then manually analyzed the trends, themes, and attitudes that were noticeable throughout the interviews and used these statements to inform my results and recommendations.

<u>The questions that were asked in interviews were, generally, the following:</u>

1. Do you find that oyster restoration is, very generally, easy or difficult to get off the ground?
    - Easy vs difficult in terms of: how much time does it take to apply, is it expensive, does it require multiple persons' knowledge/effort to complete an application, how many permits are there to apply for, do people often get denied

2. What laws/policies, if any, make oyster restoration difficult or easy for you?
    - Difficult vs. easy in terms of: efforts needed to comply, effort may include many of the same as above including time, costs, personnel, chance of denial, plus upkeep of the permit

3. Do you think that stronger/more prohibitive shellfish restoration laws would benefit this state? Or do you think the laws should be more relaxed than they are now?

4. If you have ever been denied for a permit for an oyster restoration project, do you know what the reason was? Were you able to receive the permit later on?

5. If applying for a permit for oyster restoration projects in contaminated waters was "easier" (based on some difficulties described earlier), would you participate in or support (in some capacity) an oyster restoration project in some of those areas?

- For NY people – would they participate in projects in NJ if they could?
- For NJ people: if receiving DEP permits for closed water restoration was easier would you choose to manage/participate in more projects than you are currently part of?

6. Do you have any problems with illegal harvesting of oysters as part of your oyster projects? What measures do you have in place to prevent illegal harvesting of oysters? What methods or techniques do you think would aid in continuing to prevent illegal harvesting of oysters, and if there are any what stops you from implementing them?

- Goal of this question is to understand whether poaching threat and perceived risk are aligned

7. Have you noticed or recorded any difference in water quality or biodiversity of wildlife nearby your oyster restoration projects, or have you noted any specific social or economic benefits to humans? Any scientific evidence?

8. What changes would you make to restoration policy in your state?

Policy Findings:

New Jersey

The state of New Jersey is considered to have some of, if not the utmost prohibitively strict oyster restoration policies in the United States (Ravit *et al*., 2012, TNC 2014). While it is not necessarily prohibited by policy, it is virtually impossible to conduct oyster restoration in

waters that are classified as “closed” under the National Shellfish Sanitation Program (NSSP) (pers. comm., Data).

Under New Jersey Administrative Code (N.J.A.C) “Shellfish Growing Water Classification”, rules, provisions, and procedures for the classification of shellfish waters are outlined in detail. The purpose of these rules is cited as “…to protect the health, safety, and welfare of the public from the risks associated with the consumption of shellfish” (NJAC 7:12). It is clear, therefore, that the main purpose of any law surrounding the growth of shellfish is to ensure that all oysters grown in New Jersey waters are safe and free from contamination when they reach the point of human consumption. There are no policies in place that specifically facilitate the restoration of oysters, shellfish, or living shorelines (TNC 2014).

Waters are designated into categories based on the NSSP, which is recognized by the Interstate Shellfish Sanitation Conference and the U.S. Food and Drug Administration (FDA). Designations for waters for shellfish-related activities are classified on a scale that ranges: Approved, Conditionally Approved, Restricted, Conditionally Restricted, and Prohibited (FDA 2019). It is possible for areas to change in status, but these changes must be reported to FDA offices and supported by sanitary surveys that demonstrate that the relevant water quality changes have occurred (FDA 2019). This is not unique to New Jersey; this is mandatory for all states that participate in any sort of shellfish growing, and all shellfish growing areas must be classified (FDA 2019).

New Jersey’s areas classified as Prohibited include the entire HRE area, namely the Raritan River, Arthur Kill, Kill van Kull, Newark Bay, Passaic River, Hackensack River, Upper Bay, and Hudson River, among many other regions of the state (NJAC 7:12). These waterways are directly connected to New York’s waterways, or flow directly into shared waters, which are also classified similarly (NY DEC 2023). According to N.J.A.C, waters that are “Approved” by the Department of Environmental Protection are classified based on criteria such as water quality including total coliforms, hydrological characteristics of the waterway, shoreline survey and assessment such as pollution sources nearby and land-use patterns, and other related factors (NJAC 7:12). “Prohibited” is defined in this document as “waters that meet the criteria set forth such that no harvest of shellfish is allowed for direct marketing, depuration, or relay”, and these areas are often also referenced as “closed” or “contaminated” (NJAC 7:12).

In 2010, NJDEP placed a full ban on all oyster research and restoration-related activities in closed waters (NJ DEP 2010). This forced many restoration projects, prominently including NYNJ Baykeeper's restoration efforts, to be immediately removed from New Jersey's contaminated waterways (NJ DEP 2010). At the time that the 2010 policy was passed, NYNJ Baykeeper was made to remove their ongoing oyster reef restoration efforts and dispose of them in a dumpster, which destroyed over 50,000 living oysters (McCann 2019, pers.comm, Data). The purpose of banning these oyster restoration efforts was to safeguard public health and protect the health of the State's shellfish industry (NJDEP 2010). The NJDEP had concerns that if there were shellfish being grown for restoration in waters classified as Prohibited, there was a greater likelihood that those oysters might be illegally harvested and consumed (NJ DEP 2010). If that consumption led to poisonings that could be associated with the NJ shellfish market, this would have had resounding negative effects on the $800 million yearly shellfish economy in NJ, as people typically refrain from purchasing shellfish from a market that has been associated with poisonings (Associated Press, 2019, NJ DEP 2010). The NJ DEP also added in a press release that they chose to ban research and restoration-based oysters after the FDA issued a notice to NJ, due to their inability to maintain patrol and inspection requirements of shellfish growing sites (NJ DEP 2010). Per the federal shellfish program, each state with shellfish growing activities, in addition to classifying waters, is required to carry out patrols and sanitary surveys of growing sites, which means that the quantity of inspection staff can be a limiting factor for the state (FDA 2019).

In 2016, the policy banning all research and restoration was updated, and New Jersey adopted new rules (Comi 2016). The rules were updated to bring NJ into conformance with the NSSP standards, and these new rules added some new permitting language surrounding growing and harvesting of oysters (NJ DEP 2016). Namely, this amendment added a "Permit for Shellfish Restoration in Waters Other Than Approved", as outlined above (NJAC 7:12).

Under NJAC 7:12, permits for harvest for research, restoration and enhancement, etc. are discussed. It is possible to apply for and potentially even obtain a permit for oyster restoration in areas that do not meet the "Approved" water quality standard for the NJDEP (NJAC 7:12). However, there are many strict and potentially complicating requirements and conditions that might stand in the way of a restoration project successfully receiving a permit to move forward

(NJAC 7:12). Some of the rules that would require compliance include: receipt of a Scientific Collecting Permit from the Division of Fish and Wildlife, a detailed security plan including 24 hour a day/365 day a year surveillance and patrol of the site with a legally binding agreement, and extremely detailed reporting of all shellfish activity, personnel, and project planning that takes place (NJAC 7:12). Permits have strict guidelines around size, number, and species of shellfish involved. Only nonprofit organizations and government agencies are currently eligible for permits, meaning that any individuals who wish to conduct oyster restoration projects must partner with non-profit organizations in order to obtain permits for restoration (NJAC 7:12).

Notably, at the time that the rules were being reviewed for the 2016 policy update, multiple stakeholders submitted public comments in support of the update that added the Permit for Shellfish Restoration (NJ DEP 2016). Comments related to the "Permit for Shellfish Research in Waters Other Than Approved" noted that the application and reporting requirements for the permit were repetitive of the required permit from the Division of Fish and Wildlife's Scientific Collecting Permit, and that they are generally "excessive and will stifle research" (NJ DEP 2016). Commenters on the new permit also thought that the requirements would hold back oyster restoration, especially the security plan, which may be cost prohibitive due to the 24/7 surveillance requirement (NJ DEP 2016). The DEP acknowledged in their response to the comment that they were not aware at the time of any specific instances of tampering with shellfish restoration projects in waters other than "Approved" in New Jersey; however, they insisted that the purpose of the rules and permits is to allow restoration activities in a way that will prevent poaching and harvesting for human consumption (NJ DEP 2016).

NJDEP's current rules for shellfish restoration are evidently considered unreasonable by many stakeholders and practitioners, and may make it difficult to conduct valuable shoreline resiliency research or water quality improvement projects. The rules only allow permit-free shellfish research and restoration activities in less than 1% of NJ waters in the NY-NJ Harbor Estuary (Comi 2016).

The State of New Jersey DEP does have their own oyster restoration efforts in place throughout the state (TNC 2014). However, none of these efforts take place near the New York Harbor, and are mainly concentrated in areas new Cape May, the Delaware Bay, and Barnegat Bay, where waters are Approved for shellfish growing and harvesting (TNC 2014). At this time,

possibly the only oyster restoration effort in NJ's HRE waters is NY/NJ Baykeeper's work at U.S. Naval Weapons Station Earle in Colt's Neck, NJ on the Raritan Bay (Pew 2019). Some of the main cited reasons why this oyster restoration project is able to exist are the high security at the Naval Station, strong pre-existing relationships between NY/NJ Baykeeper staff and officers on the Navy base who supported this work, and Navy buy-in based on an understanding of increased need for coastal resilience in the face of climate change (pers. comm., Data).

New York

Because the NSSP is a federal program run by the FDA, the same water classification guidelines that apply to New Jersey apply to New York, and the majority of the policy requirements are overarchingly similar. In New York, waters must also be classified based on either a fecal coliform or total coliform standard for any shellfish growing activity to take place (FDA 2019). New York waters are also classified on the same scale from Prohibited to Approved. Relevant waterways in the HRE that are Prohibited for shellfish growth for food are all waters contained within Rockland, Bronx, Kings, New York, and Queens Counties (NY DEC 2023).

Under the same federal programs, regulating authorities are also required to patrol shellfish growing areas, survey water quality parameters, and provide sanitary surveys to the FDA, which are comprehensive written evaluation reports of all environmental factors, including actual and potential pollution sources which may impact water quality in a shellfish growing area (FDA 2019). Sanitary surveys are to be submitted every twelve years. There are other reporting guidelines to be completed more often, including reporting on patrols (FDA 2019).

New York's regulators have consolidated applications for USACE and DEC permits into one, streamlined permit application (TNC 2014). Despite these provisions that reduce the strain of permit applications, members of the NY/NJ Harbor & Estuary Program Oyster Restoration Working Group still cited their greatest challenge in restoration as regulations and permitting (McCann 2019). This Working Group is bistate and may have members from New Jersey, so this data is relevant to both states (McCann 2019). Other types of permits that may be required for

restoration activities in New York include Tidal Wetlands Permit, for projects in or adjacent to tidal wetlands, and State-owned Lands Underwater Lease, which is for restoration projects on state-owned underwater lands (TNC 2014). Similarly to NJ, there are varying applicable permits based on the precise work that is being conducted. If material alteration to the area involved is not necessary for the tidal wetland activities, projects may be exempt from requiring these additional licenses. There are no provisions specifically excluding shellfish restoration activities in closed waters (TNC 2014).

There are many restoration projects already in place in the New York Harbor and around New York City conducted by state, public, and private entities. During the "Shallow Water Enhancement in the HRE: Challenges and Opportunities" panel hosted by the Hudson River Foundation, it was stated that New York practitioners have an official goal to reach 2,000 acres of oysters and oyster reef potential by 2050. Government efforts to restore oysters in the HRE are run by NYDEP and NYDEC, in conjunction with organizations like Billion Oyster Project and NY/NJ Baykeeper (TNC 2014). Non-government and private projects are run by groups like The Nature Conservancy.

Interview Results:

There were several themes and key points that arose from the semi-structured interviews. One practitioner that I spoke to who works in both New York and New Jersey put it best: "Oyster restoration is very difficult in both states". They elaborated, "It is harder in North Jersey because of the DEP laws and policy than it is in New York…they're not willing to work on anything shellfish related in closed waters".

The majority, if not all of the Hudson-Raritan Estuary, on the New Jersey side, is unable to proceed with oyster restoration projects, with the only notable project mentioned occurring in U.S. Naval Weapons Station Earle, spearheaded by NY/NJ Baykeeper in collaboration with the naval station. Based on restoration policy and corroborated by the existence of this project, it is evident that restoration in closed water in New Jersey is not strictly against the law. However, for a variety of reasons, projects rarely make it past initial proposals in NJ waters. Interviewees familiar with the Naval Station Earle project emphasized that significant buy-in from the naval

station helped push forward the approval of this project. Of course, the highly secure nature of the site helped the project to comply with NJ's strict guidelines for shellfish restoration in closed waters, which was ultimately essential for the approval of that permit.

When asked why other restoration projects in NJ were unable to move forward, practitioner responses varied. Some said that they no longer made efforts to propose or enact new projects in closed waters due to a general perception that it was not worthwhile, and a belief that they were likely to be rejected at the proposal stage. Others pointed out that a large portion of the available shoreline in the HRE is mapped as habitat for other life, including hard clams and submerged aquatic vegetation. Repurposing these sites for oyster restoration would require changing the substrate and taking away these other forms of habitat, which would classify as both fill and habitat disturbance. These are both against the regulatory agencies' "do no harm" ethos, and interfere with the ability to put forth new restoration projects. Finding locations where oyster restoration projects would not conflict with habitat appears to one of the common barriers to oyster restoration in northern NJ. This was also highlighted in conversations with NY-based interviewees, although to a lesser extent.

Another potential barrier to project implementation centered in DEP/DEC staffing in both states. Regardless of project type, oyster quantity, or security plans in a given restoration project's plan, each regulating body holds a responsibility to the FDA to ensure that illegal harvesting of contaminated shellfish is not occurring. The state organizations are required to utilize their time and resources to conduct monitoring inspections at every site that they approve for restoration. This means that individual staff from the agency must physically monitor restoration sites a certain designated number of times each year in order to comply with policy. Therefore, if the regulatory agency is unable to supply adequate staff to carry out the necessary inspections to report to the FDA, they are limited in their ability to expand the area in which restoration projects are occurring. Anecdotally, interviewees believed this lack of personnel to be a significant limiting factor in regulatory agencies' abilities to issue permits in both New York and New Jersey.

The trickle-down effect from the FDA policy and the existing rules around shellfish growing appears to have created strong policy around oyster restoration, because poaching from oyster reefs in closed waters could potentially lead to poisonings. NJ policymakers cited

poaching risk as a main reason for restricting all shellfish work in closed waters in 2016, and I wanted to determine whether that threat is aligned with experiences. I asked the interviewees about their encounters with poachers to determine the extent to which the threat of oyster poaching is valid is a reason to hold back on restoration. None of the interviewees have experienced poaching from oyster reefs in recent years. It is worth noting that due to the extremely low quantity of restoration projects permitted on the NJ side of the HRE, this finding may be biased. One participant reported hearing of oyster poaching near Soundview in the Bronx over a decade ago. Other practitioners stated that oysters have "gone missing" in the past, but it was not possible to say whether they were washed away by currents or other natural elements, or if they were illegally harvested. Several interviewees referenced poaching of wild hard clams that is regularly witnessed in Jamaica Bay, which are not part of a restoration project, but is a contaminated waterway from which food products like wild clams cannot be safely consumed. Additionally, an NJ-based individual referenced clams being collected in Perth Amboy, close to a combined sewer outfall pipe. These incidences were addressed to highlight that preventing oyster restoration does not prevent the public from consuming shellfish that were present in these contaminated waters, if they wanted to do so.

Despite the lack of actual poaching affecting oyster restoration projects, poaching prevention techniques do appear to be one of the most important factors to consider when practitioners are developing plans for new restoration projects. Creating a plan that convincingly shows regulators that there will be minimal poaching risk from the very beginning helps bolster approval. Some of the elements that have helped prevent poaching are using difficult to access devices, like gabions, cages, and sunken reefs to make oysters inaccessible to people who may want to harvest them. Another tactic is generally hiding the locations of oyster reefs- that is, refraining from sharing the exact location of oyster cages helps prevent poachers from accessing them. Placing restoration elements in locations that are deep enough that they are invisible during low tide or even impossible to access without a vessel were cited methods, as wells as placing reefs in conspicuous locations, where poachers would be unable to harvest without public attention. Finally, removing oysters from restoration projects when they approach market size is another tactic that some have employed to prevent poaching.

A point that was brought up by several interviewees with regard to poaching was that poached oysters from restoration projects would not be compatible with the oyster market in the New York/New Jersey restaurant circuit. A restoration professional in New York said, "[The National Shellfish Sanitation Plan] is geared toward the commercial sale of shellfish. Everything that is being sold in New York City is beautiful half shell oyster that farmers have worked very hard to make look a certain kind of way. They don't look like that in the wild; wild ones are irregular and 'ugly' opportunistic growers. The threat is not aligned, even growers are mostly not worried because they understand that wild stuff can't be sold into the market. Oyster farmers are generally in support of the work that [practitioners] do…". In New Jersey, practitioners said that farmers took a longer time to win over, but now mostly also support restoration projects.

The emphasis on poaching and the requirement to comply with the NSSP both point to another commonly held stance, which was that both states are lacking in specialized and appropriate policy for oyster restoration. Multiple interviewees in both states agreed that there is a lack of policy that is specific to oyster restoration. "…it's setting a precedent, it's the first policy like this ever," one interviewee said when discussing how they work with regulators to make projects come to fruition. Policies exist for waterfront development and fill, as well as for shellfish growth for human consumption, but neither state has concrete guidelines that can facilitate restoration. Another interviewee stated, "All ecological restoration is difficult because the regulatory framework is not clear or streamlined …There is very little to help guide this process and the materials that exist are more for regulating development. But once you throw in ecological restoration that permitting process is what [my organization] has to use too and it doesn't match up to the need".

Because of the lack of specific policy, fates of restoration projects appear to fall heavily onto personal interactions with regulators and creating projects that are specific to certain needs. Multiple practitioners emphasized that a key element in developing restoration projects, both in New York and in New Jersey, was having a strong relationship with regulatory agencies like the DEP and U.S. Army Corps of Engineers. Approval from these agencies is crucial to moving projects forward, and practitioners found it key to be able to communicate with regulators at multiple stages in the project development process. Lack of policy also means that organizations that have stronger relationships with regulating agencies are more likely to be able to move forward with projects, because they are able to work together. One practitioner stated, "Research

projects wouldn't have been possible if they didn't start small to understand permitting asks and deepen relationship with permitters…".

Multiple oyster restoration practitioners from non-profit and state organizations cited their long-standing historic relationships with permitters and regulators as part of the reason that they were able to get permits approved or considered. Practitioners who have close relationships with regulators are able to be proactive and incorporate feedback early in the development and design process; rather than being denied for permits when submitting official applications, they are able to tailor applications to reflect the comments of their partners. Several interviewees stated that they had never been rejected for permits, but qualified the statement with the fact that regulators had been involved from early in project development. While relationships with regulatory agencies are possibly indicative of favoritism, it is also worth noting that these individuals worked for organizations that had ample experience establishing restoration projects. As such, they were the most familiar with the policy and the expectations that were in place for projects. Regulators stated that many less-connected individuals that apply for permits with smaller projects do not understand the components that make up a feasible and well-considered restoration project, especially long-term continued monitoring aspects. Permits that were rejected were often rejected on the grounds that applicants failed to create comprehensive plans that address all aspects of project development, including end-of-life planning, monitoring, and reporting.

Almost all interviewees agreed that, for the most part, restoration practitioners and regulators have shared goals of improving the Hudson-Raritan Estuary's environmental quality, especially in recent years. A New York-based regulator stated: "I can't say there aren't some in my agency that wouldn't say they wish we'd take the same position [as NJ, 'who simply slam the door in your face and say no'] because it would make life simpler. But we also want to be progressive and open to the fact that if we can do this effectively it's going to be ecologically beneficial to do so". Another practitioner said, "The struggle is- how hard to we push on the regulatory side? We have made progress already and there's been a positive shift to being more receptive to more projects and new sites, but we always want to go bigger and increase. Pushing too hard on the DEC could backfire and lead to regulatory action that we don't want, which comes down to personalities and who is in charge at the time". A regulator confirmed,

"Everything is discretionary action- there wouldn't have to be a policy change for anything to change, permit granters would just change what threshold they want to set. They just have to meet the federal standard and be sure that the rewards are worth the risk".

All interviewees agreed that restoration efforts in the New York Harbor have not led to any statistically significant recruitment of spat or oysters to contribute to a wild, self-sustaining population in those waters. Subjects stated that a number of causes may have contributed to this lack of results thus far, including that some large projects are recently established and need time to mature prior to monitoring and evaluation of progress. One interviewee from NJ said, "We don't know what critical mass is because nobody has been able to put out enough to see…we can't study what we can do if we aren't putting animals in [the water]. There's also no substrate at all- increase in habitat is necessary". The lack of data detracts from the ability to make any definitive statements on the population or its condition. Some practitioners mentioned that the stunted volume of oysters in the system could be making a difference, because if there were more robust restoration projects occurring on both sides of the waterway, there would possibly be a greater potential for increased recruitment due to a larger base population.

Recommendations:

I used interview participant responses to inform the development of some policy recommendations and action items that may help with a number of different goals. These recommendations aim to facilitate the implementation of feasible and scientifically valid restoration projects, help create more streamlined communication within the community of restoration practitioners and regulators, and highlight long-term goals that may support these concepts in the long run. These recommendations are geared toward practitioners and state policymakers.

1. *Increase number of staff at regulatory agencies that may conduct site monitoring and inspections.*

Lack of personnel to perform this specialized task appeared to be a sticking point in both NJ and NY. Especially in NY, which has specific goals about increasing oyster restoration acreage in the coming decades, growing the number of staff in these areas will be imperative in continuing to meet reporting requirements to the FDA. This recommendation is both feasible in the short term and of high priority in order to enable new projects to move forward and grow.

Both NJ and NY have recently identified new funds to support green jobs. In NY, the Environmental Bond Act approved over $4 billion to fund environmental restoration projects throughout the state, with relevant goals of the act including climate change mitigation, water quality, and flood risk reduction (NYLCV 2022). The Environmental Bond Act is also expected to create over 100,000 new jobs in the green sector. Because oyster restoration directly supports the aforementioned goals, allocating some funds from this act to increasing the number of staff that conduct site patrolling would immediately remove a barrier from the agencies' ability to approve projects (NYLCV 2022). Similarly, in NJ, the Murphy administration announced new funds for green jobs in December 2022 in the form of the Building our Resilient, Inclusive, and Diverse Green Economy (NJ BRIDGE) initiative, which allocates $5 million to supporting green careers (State of NJ 2022). Using funds from this initiative would help place individuals into entry-level jobs in a green sector within a state regulatory agency, which would both fulfill the goals of the initiative and help encourage the development of more oyster restoration efforts in the HRE by removing a key limiting factor.

If New York is to meet the targets they set forth for 2035 and 2050 of 100 and 2,000 acres respectively, these changes will have to occur in the short-term. It is essential to learn from history, wherein NJ was forced to act drastically to avoid repercussions from the FDA in 2010 after they were unable to meet patrol requirements. Maintaining adequate patrol staff sizes can help avoid these issues in the future.

2. *Develop a recurring workshop, webinar, conference, or other engagement event.*

"A regulator came up to us in the field and said, 'Wow, this looks so different than on paper'". – NJ-based restoration practitioner

"We need a wholesale shift in perception to work together toward harbor enhancements". -NY based restoration expert

This recommendation is based in the finding that personal relationships between restoration practitioners and regulators appear to be highly influential in helping to determine shared goals and developing projects that appeal to both groups. Communication is a highly important aspect of any project or program, and by having a regularly scheduled opportunity for representatives from both groups to be present and share their perspectives, some of the difficulty in communication may be removed. Some practitioners that I spoke to also highlighted that there is a turnover in staffing that occurs on both ends of the network: new people are entering the environmental field, and with that there is bound to be a learning curve. Highly focused events like these can help fill in the knowledge gap and connect new staff with resources and a professional network, as well as an opportunity to put faces to names. During an interview, one person stated, "Practitioners need to be better about sharing data to inform policy makers". A workshop or webinar would enable groups to connect, share data, and answer questions about one another's findings and the impacts thereof.

In the case of a larger event, such as a conference, I recommend expanding to include groups such as shellfish farmers or private sectors that engage in waterfront development. Fostering relationships between restoration practitioners and shellfish growers can help align groups on topics such as best growing practices and equipment, policy needs, poaching threat, and other areas that may apply to both groups. Incorporating waterfront developers into events of this manner may help align policy interests as well. Parsing apart the difference in policy requirements between restoration practitioners and waterfront developers in a workshop working group can help determine the needs for new policy that is specific to restoration. It can also help to connect restoration practitioners to private, waterfront areas and forge relationships with people that manage them. As is highlighted in the case of Baykeeper's project at Naval Station Earle, personal relationships can make or break a project's ability to move forward. As such, utilizing these networking opportunities as a way to brainstorm ways for groups to work together

(e.g. deploying a man-made oyster reefs on the property of a waterfront restaurant) could be beneficial for all parties.

Some other topics that may be valuable to discuss at an event of this sort include:

- Priority areas for restoration expansion
- New methods or technologies for oyster growth/deployment
- Best methods for oyster monitoring
- Setting targets for future years (NJ)
- Progress on meeting targets (NY)
- Updates on policy changes
- Community education, outreach, engagement methods or material development
- Annual updates on project growth/progress/data

3. *Support more reef potential projects.*

Reef potential is any hard substrate that may support the growth of oysters. More or less any hard substrate can be considered reef potential; as long as oyster larvae can settle onto the surface, it is reef potential. According to some interviewees, there are wild populations of oysters that are established throughout pockets of the Hudson-Raritan Estuary, including parts of the Hudson River, Newtown Creek, Arthur Kill, Gowanus Canal, and Coney Island Creek. Helping maintain and safeguard the presence of these existing wild populations can help demonstrate recruitment occurrences, as well as grow populations in areas where oyster survival is already demonstrated. Another common statement from interviews was that there was little evidence of self-sustaining populations in the HRE and little habitat for oysters to continue growing a self-sustaining population. Focusing on reef potential could help create scientific evidence of oyster reproduction and population maintenance in the HRE, which would also legitimize further restoration efforts by demonstrating success of wild oysters.

Supporting reef potential heightens the likelihood of reaching total oyster population goals faster without having to dedicate as much time, money, and effort into other steps of the process, which might include growing larvae, seeding substrates, building cages, and more. A

restoration practitioner also pointed out that that sources of larvae for setting shell are limited in the NY/NJ area, due to the importance for genetic diversity in the stock and restrictions on permissions to set shell. Favoring reef potential sites may help work around these limitations.

As previously mentioned, one of the conflicts with restoration that may continue to arise with reef potential sites is the competition for habitat that occurs in shoreline spaces. This question of habitat exchange affects shorelines in both New York and New Jersey. Soft substrate for hard clams to bury and submerged aquatic vegetation are not necessarily reef potential and are considered equally important to maintain. A regulator explained to me that they understand that oysters have habitat potential as well, but it would require close and extensive monitoring to ensure that those benefits are legitimate and outweigh the impacts of manipulating the established habitat. In light of this, restoration practitioners may consider deploying reef potential that utilizes different levels of the water column. Floating structures, such as floating islands with hard bottoms, can serve as both reef potential and possible habitat for other wildlife. Suspended lines or other off-bottom structures are more affordable versions of this concept.

4. Policy Changes

"Right now, the state views it as sort of a burden. Getting over the perception of what restoration is and how it's a tool for positive change in the climate struggle, rather than the burden the state views it as, since they don't have the capacity or the resources to deal with it. They get it and understand the importance but they are confined to the way they have always regulated permits, and there needs to be a systemic change." – NY based restoration expert

In the long term, creating policy that is specific to oyster restoration will greatly facilitate the goal of creating more meaningful, scientifically valid restoration projects in the future. Policy necessities identified by practitioners in interviews included the need, in both states, for a clear definition and consistent language regarding the meaning of the word "restoration". This is important because it impacts the interpretation of new policies, permits, and long-term management plans.

Multiple practitioners in both New York and New Jersey highlighted that the policy process related to oyster restoration development is not differentiated from waterfront development. One said, “We’re not developers, so don’t treat us that way”. Creating a different permitting process that is unique to the needs and process of non-commercial shellfish and shoreline restoration is a long-term goal that would facilitate meaningful, feasible, and effective ecological waterfront improvements. It also appears to be the case that restoration practitioners are subject to policies that are geared toward the sale and growth of commercial shellfish very often. While it is important to continue prioritizing protecting human health and preventing poisonings, a long-term goal of developing policy that is specific to restoration may facilitate the safe expansion of this area of work.

Something specific in this realm might be creating a way to work around the classification of “fill” or “habitat disturbance” for shellfish restoration, since this appears to be a common issue. People have pointed out that this comes from a stance of first and foremost preventing harm to existing environments, but experts are stating that even through natural processes, we are beginning to see degradation (Shallow Water Enhancement Panel, HEP Conference 2022). One way to organize this, as highlighted in the panel, may be by developing a spectrum of scarcity versus restorability to determine what habitats are most necessary and possible to restore. Focusing on these priority areas and analyzing habitat disturbance on a case by case basis might prevent further habitat loss to oysters and other species.

In similar theme, some interviewees highlighted that there are permits which double up on the same requirements or overlap in context. For example, in New Jersey, it was pointed out that the NJ Living Shoreline Permit overlaps with the Army Corps Living Shoreline Permit #54, making it outdated. The state may choose to update permits to reduce burden on practitioners so that they do not have to repeat efforts or costs associated with permit application. A NJ-based policy specialist acknowledged that NJ is attempting to address and streamline some permits but added that it is an ongoing problem for quite some time now and requires more urgent action.

Other potential avenues that policy changes could use to further shellfish restoration might be by considering incentives for private property owners in order to implement restoration on smaller scales. Incentives for habitat enhancement, for example, would help grow the quantity of oyster reef or reef potential area, with relatively minimal risk, as private property bears less

risk of trespassers than state-owned waterfront areas. Advocating for these changes in the future could make small strides in growing the wild oyster population in the HRE.

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