A Preliminary Review of Literature towards the RFP development to estimate the economic importance of water quality in the NY-NJ Harbor Estuary Region

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Introduction

The New York - New Jersey's (NY-NJ) Harbor Estuary coastal ecosystem is a priceless asset, contributing considerably to the prosperity and the quality of life of those living near and far. NY-NJ Harbor Estuary is one of the most naturally diverse places on the eastern seaboard, supporting 12 square miles of tidal wetlands, with over 200 species of fish, and over 300 species of birds (HEP state of the Estuary, 2018). This natural diversity is juxtaposed with the New York metro area, one of the nation's most densely populated urban areas, with over 14 million people living along the Harbor Estuary's waterways. The NY-NJ Harbor Estuary supports a multi-billion-dollar port, industrial, and transportation complex, making the region both economically and ecologically important.

Based on the analysis presented in the Harbor Estuary Program's 2018 State of the Estuary report, while some indicators of water quality are improving, several indicators are trending downwards. Table 1 presents a summary of some critical downward trends in water quality indicators and the affected ecosystem services. Deteriorating trends in enterococcus, average bottom water temperature, riparian area integrity, and acres of tidal wetlands affects the well-being of both residents in the region and visitors. A healthy NY-NJ Harbor Estuary offers ecological, recreational, and commercial benefits such as recreational fishing, bird watching, beaches, waterfront parks, mitigation of local flooding, boating, swimming and other water sports, tourism, marine trade, energy distribution, ocean views and their associated value as captured in the housing market, sequestration of carbon dioxide, and plant and animal habitat.

This economic study will be the first of its kind in the region, underscoring the need to provide a valid estimate of the economic value of ecosystem services the NJ-NY Harbor Estuary offers, and will serve as a steppingstone for further work. When complete, the outcomes of this analysis will communicate the economic importance of the estuary to residents, stakeholders, and decision makers. Though the current study is not evaluating a specific policy proposal, it is doing the equally important task of estimating the economic values at stake as the result of inaction towards addressing deteriorating water quality.

Economic value is different from cost or price. It represents how much the use of a resource improves the economic wellbeing of one person, or of society at large. Economic wellbeing is the value added, that is, the excess of benefits over the costs. As many coastal resources and associated recreational activities cannot be captured and sold directly in the market, such as fishing or swimming at a public beach, market price seldom captures their value. Therefore, for this project, economic value represents the value people place on the coastal and estuary resources, beyond what they have to pay to access these resources. Economic value is different from the measurement of money, jobs, and taxes generated by an activity. Within economics, jobs are rarely considered an economic value, as wages from a new job are a benefit to the employee but a cost to the employer, washing out in net. As another example, the $10 a family might spend towards parking to access a public beach would be still retained in the economy and spent elsewhere if the beach were unavailable for their enjoyment due to poor water quality.

The flow of economic value or benefits from the estuary is acutely tied to its water quality and the health of the associated ecosystem through its influence on people's behavior. The types of economic values from NY-NJ Harbor Estuary includes value placed on goods and services consumed directly, such as beach-going; consumed indirectly, such as healthy wetlands that reduce bacterial contamination in the water; and even ones that may never be consumed, such as a donor who may never visit the NY-NJ Harbor Estuary but values its health and existence, and wants to preserve it for future generations.

Understanding, accounting for, and estimating the many potential economic values or benefits of protecting and restoring water quality of this asset is a difficult, yet vital, task. Estuary managers, regulatory agencies, and decision makers often encounter a situation where an economic analysis is needed, but are constrained by time, funding, and a lack of data to conduct a full-scale assessment of benefits and costs. This preliminary literature review seeks to highlight the existing literature, identify trade-offs among approaches to economic valuation, and provide guidance on the methodological approaches that best serve the goal and budget of this project.

Background on the current state of relevant research for the NY-NJ Harbor Estuary

Based on our research, we could not locate any economic valuation studies specifically examining the NY-NJ Harbor Estuary's water quality in the existing literature. This is unsurprising, as primary studies in Environmental Economics are not available for large portions of the country due to time and funding constraints. Because the NY-NJ Harbor Estuary is an understudied region, this project represents an opportunity for NEIWPCC to release a first-of-its-kind, highly influential study that can draw attention to regional water quality issues and motivate future research into the region. Given the significance of this study, in addition to a review of relevant literature from surrounding and comparable regions, we also provide guidance on best practices to employ in designing the very first study in the region.

Located 80 miles east of New York City, Long Island's Peconic Estuary System (PES) is the most proximate site to the NY-NJ Harbor Estuary, where a set of studies were conducted estimating the economic value of water quality and associated ecosystem services. PES consists of more than one hundred bays, harbors, embayments, and tributaries, and provides services such as recreational fishing, boating, wildlife and bird watching, beaches, wetlands, animal habitats, and parks. PES also provides critical nursery and habitat services for fish and shellfish species important to commercial fisheries. PES is a seasonal economy, but faces pressure from suburban sprawl, leading to a decline in water quality and habitat fragmentation (SCDHS,1992).

A related set of four studies from the late 1990s to early 2000s provides a broad-based economic valuation of the PES. These studies apply hedonic property valuation (Johnston et al. 2001; Opaluch et al.1999), Travel Cost Model (Johnston et al.2002; Opaluch et al. 1999), Wetlands Productivity Value (Johnston et al. 2002), and Contingent Choice Model (Johnston et al. 2002; Opaluch et al. 1999) to estimate the diverse economic values provided by PES. Johnston, et al., 2002 shows the relationship among the four methods to estimate economic values, and how they may be carefully combined together to understand the economic value of PES.

Hedonic analysis shows that residential property adjacent to preserved open space, on average, has a 12.8% higher value per-acre than a similar parcel located elsewhere. A parcel of land located next to a major area highway has, on average, a 16.2% lower per-acre value than a similar parcel located elsewhere. The Contingent Value survey determined the range of annual per-acre values residents and visitors placed on the restoration and protection of farmland ($9,200-14,400), undeveloped land ($1,740-$3,000), wetlands ($7,030-$9,500), shellfish areas ($3,900-$6,580), and eelgrass habitats ($8,700-$11,800), all figures adjusted to 2020 dollars. While the Hedonic study finds a 13.3% decrease in value per-acre adjacent to a working farmland, as a result of noise and smells, the Contingent Choice survey finds an average resident in the Peconic Estuary study site positively values the existence of farmland in their community. As local residents, property owners, and visitors value different coastal assets differently, it is important that the proposed study in the NY-NJ Harbor Estuary consider economic value for different demographics.

Based on a recreational survey administered to residents, second homeowners, and visitors to PES, the Travel Cost study estimates the annual economic value of bird and wildlife watching is $46 million, recreational boating $31 million, recreational fishing $41 million, and swimming $20 million, all in 2020 dollars. The Travel Cost study specifically estimates improvements in water quality relevant to the potential changes in recreational activities across the five bays in the study region. Water quality data on nitrogen, coliform counts, water clarity, and brown tide cell counts were used in the model. The statistical linking of swimmers' subjective perceptions of quality with objective measures of water quality allowed researchers to more accurately model visitors' behavior. The study found PES swimmers benefited by $2.2 million from a 10% improvement in the above water quality indicators. Speaking to the human behavioral component, swimmers valued water clarity much more than coliform counts, the indicator that actually affects their safety. In providing the relationship between measured changes in water quality, human perception, and changes to the benefit derived by a particular recreational user group, the Travel Cost Model provides insights helpful to policy making and outreach.

One of the downward trending indicators of ecological health associated with water quality in the NY-NJ Harbor Estuary region are the eelgrass and salt marsh areas. As part of economic valuation studies in PES, economists, in collaboration with an ecologist, conducted a wetland productivity analysis (French and Schuttenburg,1998; Johnston et al. 2002). The analysis of marginal (or additional) changes in wetlands is translated into productivity in food web and habitat values, which in turn are assigned economic value based on commercial and non-market values. Marginal asset values of PES wetlands are substantial, even without incorporating economic values from protection from erosion and storms, aesthetics, and existence value. The study estimated marginal values of both existing and restored wetlands. For existing habitats, the annual productivity value per acre of eelgrass is $ 21,168, salt marshes $7,318 and inter-tidal mudflats $1,340, all calculated over a period of 25 years discounted at 7%, in 2020 dollars. For restored habitats, the annual productivity value per acre of eelgrass is $17,048, salt marshes $5,891 and inter-tidal mud flats $1,068.

The NY-NJ Harbor Estuary is the largest public space in the metro region, meaning access to its waters has a significant impact on the quality of life of residents and visitors (Boicourt, 2016). Increased access to waterways could unlock the benefits from cultural ecosystem services to residents. Environmental education is understood as a "cultural" ecosystem service. In a recent study, Hutcheson, Hoagland and Jin (2018), using a travel cost model, estimated the economic value of the Hudson River Park's environmental educational programs for elementary and high school-age children, based on data on school and summer camp visits from 32 New York City school districts during 2014 and 2015. Many of the park's educational programs are marine science-related, designed to educate the students about the estuary and its ecology. This study sought to estimate a range of plausible cultural ecosystem service values arising from the park's education programs for K-12 schools and camps that teach the science and ecology of the Hudson River and Estuary. The estimated annual ecosystem service values for the park's estuary education programs ranged from $7,500 to $25,500. It is notable that given only 9% of the waterfront is accessible to low-income and predominantly minority communities in New York City, the study found that the park's estuary education programs were well attended by organizations in school districts with high proportions of minority students or English-language learners. Emphasizing the value to this community, in addition to all other economic values generated by the NY-NJ Harbor Estuary, could lead to policies to expand public access to waterways.

Although most coastal recreational activities are non-traded goods in the market, they have significant economic value that non-market valuation can help estimate. Leeworthy and Wiley (2001), used the National Survey on Recreation and the Environment to estimate the number of participants and the number of days of participation for 19 categories of coastal recreation across 24 states in the United States. Based on the output from the above survey, Pendleton (2011) estimates an economic value (consumer surplus) from beach-going (including swimming, bird and wildlife watching, and other activities that occur at the beach) of $271 - $1,089 million in New Jersey, and $194 - $778 million in New York using the Travel Cost Method. Based on findings from Norton et al. (1983) and McConnell and Strand (1994), Pendleton (2011) estimates about 15 million activity days towards recreational fishing in each of the states of New York and New Jersey, translating into an economic value to recreational fishermen between $290-$1,932 million in New York and $220-$1,955 million in New Jersey. The economic value of birdwatching is between $327-$3,267 million in New York and between $250-$2,502 million in New Jersey, all in 2020 dollars.

There are two caveats to these studies: while these economic values in these studies appear significant, they do not include several yet-to-be studied ecosystem services as discussed below. McPhearson et al. 2014 reviews the current understanding on urban ecosystem services in New York City, highlighting the presence of non-recreational services, such as storm water surge and flood control, climate regulation, temperature regulation, esthetic value, raw material, air purification, carbon sequestration, drinking water quality, and food provisioning. We recommend the proposed study develop a conceptual list of all ecosystem services associated with water quality in the NY-NJ Harbor Estuary to help serve as a basis for future work.

Combining the above dollar estimates into a larger figure must be done carefully to avoid double-counting (see Johnston et al. 2002, for best practices). The above studies illustrate the potential large economic value that traditional market-based transactions do not capture. The significant economic value from coastal recreation depends on ecosystem health and water quality. Beach attendance has been shown to be affected by the presence of pathogens (Bocksteal, Hanemann, and Kling, 1987; Bockstael, McConnell, and Strand 1989; Murray, Sohngen and Pendleton 2001; Smith, Zhang, and Palmquist 1997). The estimates from Leeworthy and Wiley (2001) do not determine a relationship between changes in economic behavior and changes in water quality, providing little information on the economic value at stake from inaction in the face of declining water quality.

As mentioned earlier, none of above studies estimate the economic value of NY-NJ Harbor Estuary region's water quality, highlighting the geographical gap in the literature. To elevate the cost of inaction and need for policy proposals, future studies need to specifically relate water quality indicators in the NY-NJ Harbor Estuary to human behavior so as produce valid and actionable economic data. The following sections discuss approaches to economic valuation, their trade-offs, and best practices that can achieve the goal of the current project.

Using a Benefit Transfer approach for the proposed NY-NJ Harbor Estuary economic study

A full-scale cost-benefit analysis can be costly and time-consuming. In such a situation, Benefit Transfer (BT) can be a very useful tool. BT is the application of economic benefit or value estimates reported in existing nonmarket valuation studies to calculate the value to relevant demographics in a new geographical and policy context. Using best practices, BT can yield valid and relevant estimates of the economic value of water quality improvement in the NY-NJ Harbor Estuary. With this method, the outcome of NY-NJ Harbor Estuary's economic analysis will communicate the economic importance of the estuary to residents, stakeholders and decision makers. In addition, a high-quality analysis provides a solid foundation to motivate further study of this understudied region. The rest of this section highlights relevant studies in other regions and best practices to guide the implementation of the proposed project.

There are two broad types of Benefit Transfer–a unit value transfer and function transfer. A unit value transfer is a simple transfer of the estimated economic value from one site to another, accounting for inflation as needed. While such an approach yields quick "results", it raises questions about the validity of such valuation, as it does not incorporate differences in environmental and socio-economic contexts between the two sites. *We do not recommend a unit-value based BT for the proposed study*. In function transfers, an economic function (a mathematical relation) from one or more sites (including a meta-analysis) is transferred to the new site. Function transfers that incorporate site-specific scaling, spatial variations, and modifications to account for social and biological conditions in the targeted site would produce results valid from an ecological perspective, highlight the economic value at stake from inaction, and relate changes in water quality to changes in human behavior, all of which contribute to changes in the economic value. *We recommend a function transfer based BT for the proposed study*.

We provide two examples of Benefit Function Transfer below. Kauffman (2018) estimates economic benefits of improved water quality in the Delaware River using the Benefit Function Transfer method with values modified to site-specific factors. The Delaware River Basin serves 13 million people, including NYC and Philadelphia, with the river extending 330 miles from the Catskill Mountains (NY) to its mouth at Cape May (NJ). The above study was conducted to estimate the economic value of improvement in water quality in the river, in response to scientists calling for improving the dissolved oxygen (DO) in the Delaware River from 3.6 mg/L at the time of the study to a fishable quality of 5.0 mg/L. Improvement in the DO would boost tourism, fishing and hunting, recreation, real estate values, and drinking water quality. The estimated annual economic benefits associated with improved water quality range from $441 million to $1.26 billion, with the most benefits going to recreational boaters ($55-$398 million), followed by recreational fishermen ($129-$241million), agriculture ($9-$224 million), non-use value ($91-$137 million)[1], bird watching ($18-$39 million), increased property values ($15-$32 million), municipal water supply ($14-$29 million), commercial fishing (up to $20 million), and navigation ($8-$19 million), all in 2020 dollars. A similar function transfer approach from similar sites, calibrated for NY-NJ Harbor Estuary's socio-economic and ecological conditions, can provide a broad range of economic values from various ecosystem services affected by the water quality.

Lyon et al. (2018) is an example of meta-analysis based Benefit Function Transfer estimating the economic value of public beach closures on Cape Cod, allowing for variations in water quality among the four beaches studied. *Enterococcus* concerns resulted in beach closures by the towns. They combine meta-analysis of 98 observations from 25 studies with a panel regression model using site-specific beach visitation and water quality data. Five of the studies were focused on multiple regions on a national scale, seven were specific to New England, two were from the Midwest, six from the South, and eight from the Western region of the United States. This study estimates the economic value of beach visitation from the 4 beaches to be $4.7 million, in addition

[1] These are economic values people assign to water quality improvement in this river even if they never have and never will use it, but derived value from its availability to others now and in the future, the overall health of the ecosystem, and its existence

to direct revenue from municipal parking of $650,000. Had the water quality been "pristine," they estimate the economic value from beach visitation would have been $10 million for the four beaches, highlighting the lost economic value and the importance of storm water management and other water quality projects. There are about 130 beaches on Cape Cod, demonstrating the potential economic value at stake[2]. Given the rising water temperature (which affects dissolved oxygen) and *Enterococcus* issues in the Hudson River, recreational activities such as kayaking, recreational fishing, and swimming are likely to be adversely affected; therefore, a BT based on a meta-analysis or a function transfer adjusted for NY-NJ Harbor Estuary's conditions will yield valid and useful estimates of the recreational economic value directly related to its water quality.

BT based on a unit-value transfer is highly susceptible to errors and should be avoided for this study. Phillips and McGee, (2016) apply the estimated ecosystem service values from prior primary studies to the geographic extent of land use types within each study area. These "normalized" values of dollar value per acre are applied to all areas having the same land cover and land use in the Chesapeake Bay watershed, assuming fixed dollar per acre unit value for each land use type. This approach, while alluring in its simplicity, is vulnerable to serious error as it does not account for site-specific ecological and economic factors critical to determining economic values. These include which demographics benefit from improved ecological conditions, their proximity to the site, available substitutes (if any), ecological differences between the original and present study site, baseline environmental and economic conditions, and changes in those conditions. Answers to the above questions are known to have a strong influence on stakeholders' economic values. Unit-value transfer is highly susceptible to errors, and its validity is frequently questioned by ecologists, environmental economists, and the public. If an unit value transfer is needed for the proposed study, we recommend following the best practices described in Rolfe et al (2015).

To minimize the likelihood for transfer error and bias, we recommend the following papers for guidance on best practices for conducting Benefit Transfer: Newbold et al.(2019), Boyle and Parmeter (2017), Rosenberger and Loomis (2001, 2017), Bateman and Jones (2003), and Johnston et al. (2015a)[3]. The consensus in the literature is that Benefit Function Transfers that can be updated with data from the proposed study area typically contain less transfer error and bias than a simple unit value transfer.

Based on standard best practices, we recommend the following guidelines to reduce error and improve the validity of the estimated economic values:

1. The biophysical conditions at the original study site and targeted sites should be as similar as possible to allow for calibration of the transfer function.

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[2] Also see other similar studies, Kreitler at al. (2013) and Rabinovici et al. (2004)

[3] Also see, Guignet et al. (2019). This study illustrates the use of a mean unit value for BT based a nationwide meta-analysis estimating the impact of water clarity on home prices.

2. The scale of the change in water quality and the associated ecosystem of the original study site should be similar to NY-NJ Harbor Estuary region.

3. The socioeconomic characteristics of the population at the original study site should be similar to the population of the NY-NJ Harbor Estuary region.

4. The valuation method at the original study site should have been conducted scientifically suitably.

5. Combining information from multiple studies can improve the accuracy of benefit transfer.

6. Benefit Transfer should use a meta-analysis that includes a variety of literature sources, with an emphasis on peer-reviewed published journal articles, and some government reports, white papers, and gray literature to reduce publication bias.

7. Spatially explicit analysis should identify the geographical extent and the rate of distance decay in residents' Willingness-To-Pay for water quality improvements in the NY-NJ Harbor Estuary.

8. In perusing a meta-analysis, it is important to separate value functions by recreational activities to reduce transfer error.

The goal of this study is to highlight the economic importance of improving the water quality and health of the associated ecosystem in the NY-NJ Harbor Estuary, having implications for both inaction and future policy. We strongly recommend a Benefit Function Transfer, ideally based on a meta-analysis, following the above best practices to best achieve the goal of this project and for further study of the region.

Based on our review of relevant literature and best practices, *we do not recommend an Economic Impact Analysis (EIA)*. An Economic Impact Analysis represents the amount of money, jobs, and taxes that are generated by an activity. Many coastal recreational activities cannot be captured and sold directly in the market. For example, consider swimming at a public beach, bird watching at a wetland, or fishing from a public pier. EIA does not take into account water quality, underestimates the economic value of recreational activities associated with clean water, ignores equity issues as it aggregates outcomes realized over diverse demographics, and is based on unrealistic assumptions about the economy. For the above reasons, EIA does not make a strong case to highlight the economic importance of improved water quality in the NY-NJ Harbor Estuary. As a first study in the region, lacking peer-reviewable rigor, EIA does not position it to serve as a springboard for serious future research. When done well, BT can estimate the economic value associated with improved water quality to make a rigorous case for the economic importance of clean water in the NY-NJ Harbor Estuary[4].

Our Recommendations

We recommend a highly defined goal and scope for this project. With the above context, we suggest the goal for the proposed study be to highlight the economic value of improving the water quality and health of the associated ecosystem in the NY-NJ Harbor Estuary, having implications for both future policy and inaction. Given the ecosystem services affected by the trends in NY-NJ's water quality, as summarized in Table 1, we recommend a focus on the economic value of recreational uses. The scope of this first study in the region could be an estimation of recreational economic values, such as fishing, swimming and recreational boating, tied to water quality in the NY-NJ Harbor Estuary.

Based on the reported trends in the HEP's 2018 State of the Estuary report, for the above proposed scope, we recommend that the water quality is measured by water temperature and Enterococcus levels. Reported increasing trends in average bottom water temperature reflect the overall health of the ecosystem, including effects from climate change, and even small increases in water temperatures can affect the growth, behavior, and species distribution of aquatic animals, thus affecting recreational fishing. Enterococcus contamination levels are reportedly above acceptable levels, confirming public perception of the water quality of the Hudson River, which affects swimming and kayaking. Choosing water quality measurements that capture the ecological condition and represent a public perception of water quality is vital for estimating the influence of water quality on people's recreational behavior. Despite water quality concerns, nearly 6,500 people took part in 36 organized swimming events in the Hudson River in 2014, according to Riverkeeper.org, a non-profit focused on rivers and tributaries in the NYC region. This anecdotal information speaks to the latent demand for swimmable water quality in the region.

Given the budgetary and time constraints, we recommend the NY-NJ Harbor Estuary study use a Benefit Function Transfer, following best practices, ideally including a meta-analysis, to estimate the economic value of water quality improvements at the study site. Benefit Transfer through meta-analysis can be a more vigorous approach compared to unit-value transfer, as it captures heterogeneous value estimates, thus reducing transfer error and bias that can occur as a result of transferring from a single study (Shrestha, Rosenberger and Loomis, 2007; Rosenberger and Phipps, 2002; Smith and Pattanayak, 2002). Compared to a primary valuation study, Benefit Function Transfer is also less expensive and can be executed in a shorter time frame. We have also provided a list of data sources and references at the end of this document, which we believe will further shorten the time required to aggregate relevant studies for BT.

[4] For an extended discussion about the shortcomings of EIA, please see the Appendix

We also recommend that the proposed study conceptually identify the yet-to-be-valued ecosystem services directly and indirectly associated with NY-NJ's Harbor Estuary's water quality as part of a discussion on future research topics.

By following our recommendations, we believe the proposed study will communicate the economic importance of the estuary to residents, stakeholders, and decision makers, with the credibility of a valid economic analysis that can serve as a catalyst for future analysis of this understudied region.

Online Data Sources

1. The Environmental Valuation Reference Inventory (EVRI) is an international database of non-market studies. EVRI allows the users to choose the goods or services valued and identifies studies with the potential for benefits transfer. The EVRI contains concise and detailed information about the methods and approaches taken in existing valuation studies. http://www.evri.ca/

2. National Ocean Economics Program (NOEP) provides a full range of the most current economic and socioeconomic information available on changes and trends along the U.S. coast and in coastal waters. Researchers, primarily economists, policy analysts, and computers scientists, identify, collect and formulate primary and secondary source information, then analyze and interpret it. This information undergoes a rigorous review process for accuracy and utility, and is delivered in a range of formats through a publicly available Web-based information system. Additional products such as state summaries, customized trends analyses, and forecasting are provided at a negotiated fee. https://www.oceaneconomics.org/

3. University of California, Davis has created a Beneficial Use Values Database (BUVD), an informational database of economic values for beneficial uses of water collected from a variety of sources, including scholarly journals, books, conference proceedings, government reports, and working paper series. The intention behind creating this database is to provide a useful guide for decision-makers, policy analysts, and others interested in valuation of water resources to find information on the types of economic values available for water-based amenities. http://buvd.ucdavis.edu/

4. NOAA's Digital Coast was developed to meet the unique needs of the coastal management community. The Digital Coast is a curated collection of high-quality, authoritative data and tools focused on coastal and ocean issues and directed at decision makers, practitioners, and technicians. Digital Coast was developed and is currently maintained by the NOAA Office for Coastal Management, and hundreds of organizations and federal, state, and local agencies have contributed content. https://coast.noaa.gov/digitalcoast/

5. Ecosystem Services Partnership (ESP) connects over 3,000 ecosystem services scientists, policy makers and practitioners who work together in more than 40 working groups and a growing number of National Networks on all continents. ESP has created a database of studies to provide better information on the economic benefits of ecosystems and biodiversity, and on the costs of their loss, which now contains over 600 studies and more than 4,000 value records distributed across all biomes, services and geographic regions.
   https://www.es-partnership.org/esvd/

6. National Survey of Recreation and the Environment (NSRE) is the only comprehensive source for estimates of coastal recreation activity for the entire United States.
   https://www.srs.fs.usda.gov/trends/nsre-directory/

7. Recreation Use Values Database (RUVD) is a database of 421 primary studies on recreation use value from North America. http://recvaluation.forestry.oregonstate.edu/

Table 1:
Status of water quality in NY-NJ Harbor Estuary and Impacted Ecosystem Services

Indicators of water quality and health of the NY-NJ Harbor Estuary ecosystem	**Status**	**Ecosystem Services affected**
Dissolved Oxygen (DO)	(**Improving**) Incidents of low dissolved oxygen have decreased significantly throughout the Harbor Estuary with time. Warmer temperatures also decrease dissolved oxygen in the water column, and increase biological oxygen demand (Najjar et al., 2000).	DO affects fish and other aquatic organisms' habitat, related to recreational fishing and is an indicator of the overall health of the water in the Harbor Estuary
Pathogen (Enterococcus)	(**Acceptable limit varies by region**) The analysis of shoreline Enterococcus contamination has shown that it is very common for waters to exceed the acceptable criteria of 35 cells/ML.	Recreational water use, such as swimming, kayaking, park use and beach use
Water temperature	(**Deteriorating**) Average bottom winter water temperatures are increasing significantly with time, which indicates a declining trend in environmental health. Rising temperatures affects dissolved oxygen in the water.	Even small increases in water temperatures can affect the growth, behavior, and species distribution of aquatic animals
Estuarine and diadromous fish abundance	(**Varies by species**) Both estuarine and diadromous fish populations are trending down over the long term, although some species are increasing in stock.	Impacts recreational fishing, and to a limited extent is an indicator of the overall health of the ecosystem
Riparian area integrity	(**Deteriorating**) Riparian areas are being converted to urban uses at the rate of 122 acres per year.	Nutrient pollution filtration, wildlife habitat, water quality, fisheries support, flood/storm protection, recreation, and climate regulation
Terrestrial habitat	(**Deteriorating**) Harbor Estuary lost 471 acres of coastal forests to developed open space, such as lawns and other urban development.	Coastal forests and grasslands are uniquely adapted to saltwater and strong winds and provide critical habitat for plants and animals.
Wetlands	(**Deteriorating**) Extreme loss to urban development. By 2012, more than 85% of the Harbor Estuary's wetland have been lost. Currently the restoration rate is below the rate of wetland loss.	Wildlife habitat, water quality, fisheries support, flood/storm protection, recreation and climate regulation

Source: HEP State of the Estuary report, 2018
Note: There is considerable geographical variation in some of the above indicators, requiring a geographically sensitive approach to estimating the value of ecosystem services.

Appendix

Disadvantages from pursuing an EIA for this project.

1. EIA studies do not measure the value or benefit of water quality. Aggregating the monetary value of water-dependent and water-enhanced sectors of the economy in the NY-NJ Harbor Estuary does not inform the policy makers how these sectors might be impacted by lower water quality. Since not all water related or enhanced industries are affected by changes in water quality, such as ferry service and commercial shipping, the aggregate "economic impact" number would mean little in relation to concerns about water quality. Many of these impact studies have a hard time linking environmental changes like water quality to economic activity, as they lack any behavioral component.

2. Economic Impact Analysis underestimates coastal recreational activities. Many coastal recreational activities cannot be captured and sold directly in the market. For a simplified example, consider a family of four's weekend day at a public beach. The family brings their homemade picnic with them. Aside for a small fixed cost of parking at the municipal lot, say $10, access to the public beach is free. According to EIA, the direct economic impact is the $10 this family spent on parking. However, the economic value is the dollar amount this family would lose if this beach wasn't available to them due to poor water quality. Typically, literature for the North-East region estimates this value at about $30 per person per day besides the $10 parking cost. Therefore, for the family of four loses $120 in economic value, and the town loses $10 in revenue from parking fees. In this highly simplified example, the EIA captures less than 10% of the economic value from beach going. If the family could not to access this beach, they would have kept their $10 they would have spent toward parking and spent it elsewhere, keeping that expenditure (or economic impact) in the economy. In making a case for preserving a critical habitat associated with improved the water quality or to show the economic value at stake, EIA understates the economic importance of preservation and restoration.

3. Impact models focus on aggregate outcomes realized over diverse demographics, but the equity of outcomes is also highly relevant to policy decisions. Information on the divergent effects of changes in economic value on different population groups (residents, oceanfront property owners, visitors, etc.) from changes in water quality and changes in access to water, an important aspect of economic analysis, is something economic impact models are not designed to consider. This is important, given that only 9% of the NYC waterfront is accessible in the high-need and predominantly minority communities in NYC. To increase the likelihood of incorporating equity into future policy decisions and later studies, the proposed study could calculate this statistic for the entire NY-NJ Harbor Estuary region.

4. Many impact studies have difficulty linking environmental changes, like water quality, to economic activity, because they lack any behavioral component. This approach misses

information such as how much water quality affects peoples' spending on recreational activities. Without a true economic behavioral study, EIA studies often rely on impractical assumptions to generate their results. Our review of the most popular economic impact models used (ex: REMI and IMPLAN) reveals that their mathematical modeling assumptions are not grounded in ecological science and environmental economics.

5. Though the current study is not testing a specific policy proposal, it is doing the equally important task of estimating the economic value at stake as result of inaction towards deteriorating water quality. For this purpose, marginal values, rather than the total value of all systems, are important because most policies address relatively small changes in coastal habitats. Decisions are rarely about preserving (or not) entire ecosystems, but affect preservation of an additional amount of wetland, or increasing the percent of DO in the water. As in natural sciences and social sciences, the accuracy of economic value estimates and predictions are generally highest for marginal changes. As estimations are applied to larger changes from the current condition, accuracy suffers, leading to inaccurate economic values and bad policy recommendations. As a first study in the region, lacking peer-reviewable rigor, using this method is unlikely to serve as a motivation for serious future research.

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