Buffer Options for the Bay

AN INTEGRATED ASSESSMENT EXPLORING THE TRENDS,
SCIENCE, AND OPTIONS FOR BUFFER MANAGEMENT
IN NEW HAMPSHIRE'S GREAT BAY WATERSHED

INTEGRATED ASSESSMENT

Buffer Options for the Bay was sponsored by the National Estuarine Research Reserve System Science Collaborative, which supports collaborative research that addresses coastal management problems important to reserves and their communities. The Science Collaborative is funded by the National Oceanic and Atmospheric Administration and is managed by the University of Michigan Water Center.

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Buffer Options for the Bay: Exploring the Trends, Science, and Options of Buffer Management in the Great Bay Watershed

PROJECT EXECUTIVE SUMMARY

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In New Hampshire, the need for trusted, relevant science is experienced at every scale of buffer management, from decisions made by property owners at the water's edge to those of state agencies setting policy for what's permissible on that land. Underpinning each decision is a series of tradeoffs that reflect assumptions held about the impact of that choice on the environment, the economy, and the well-being of the community.

To enhance the capacity of New Hampshire stakeholders to make informed decisions about buffer management in the Great Bay watershed, a grant-sponsored collaboration of public, academic, and nonprofit organizations conducted an *integrated assessment*—an interdisciplinary analysis that puts equal weight on technical and stakeholder input to evaluate management related to a central coastal management question. The question this project addressed was *What are the potential regulatory and non-regulatory options for addressing the challenges to effectively protecting and restoring buffer zones around New Hampshire's Great Bay?*

Nicknamed "Buffer Options for the Bay" (BOB), the project conducted literature reviews of the natural science, economic, and social science aspects of buffer management, an analysis of the state's regulatory and non-regulatory policy options for buffer management, an economic analysis of the values placed on the water quality benefits provided by buffers, a GIS analysis emphasizing buffers in the Great Bay region, a synthesis of New Hampshire takings law, and an assessment of the barriers and opportunities related to buffer management at the community level in the Exeter-Squamscott subwatershed.

The results of these analyses were captured in individual reports. As they conducted these analyses, team members generated many ideas for research, analysis, and outreach. They captured these in a collective action plan to encourage collaboration among outreach professionals as they work with towns on advancing effective buffer policy and practice at the community level.

The reports and the action plan have been integrated into an online framework intended to inform discussions around buffer management in the region, open the door to new and needed research, and encourage strategic investment: www.bufferoptionsnh.org. This final report includes a summary of the project's findings and its collaborative process, as well as the individual products generated throughout the project.

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Buffer Options *for the* Bay

EXECUTIVE SUMMARY

Overview

The Buffer Options for the Bay (BOB) project set out to address an ambitious goal, namely to leverage the capacity of buffers to protect water quality, guard against storm surge and sea level rise, and sustain fish and wildlife in New Hampshire's Great Bay Estuary region. As a part of this process, we sought to identify a menu of potential options, both regulatory and non-regulatory, that stakeholders can use to effectively protect and restore buffer zones. The project's intent was to synthesize the best available information regarding buffers in the Great Bay Estuary (GBE) watershed, not to provide specific recommendations for action. However, we hope the synthesis of our collective work offers a strong foundation for those looking to develop tactics aimed at effectively managing buffers and the services they provide in coastal New Hampshire.

As with many environmental issues, the challenges associated with buffer management stem from the complex interplay of natural systems, community perspectives and values, economics, and the regulatory environment. This complexity speaks to the need for a multi-disciplinary approach. To this end we assembled a diverse team of experts encompassing resource managers, social scientists, ecologists, hydrologists, and economists. This team produced a range of detailed and stand-alone products including a synthesis of buffer-related peer-reviewed literature in the fields of ecology and economics; an assessment of community attitudes and values towards buffers; an analysis of municipal and state policies relating to buffers; an economic valuation of water quality in the Great Bay ecosystem based on a meta-analysis approach, and maps identifying priorities for buffer protection and restoration within the watershed. The team also compiled a detailed list of potential actions that can be taken to advance the effectiveness of buffer management in the watershed. The nearly 50 items identified in this Action Plan encompass recommendations for community outreach and education, conservation, economic assessment, enforcement, mapping, policy, and further research. Some of these actions were met through the BOB project, however, many were beyond the scope of the project and remain possible future targets for collective action.

This summary harnesses the power of these products by identifying places where recurring and complementary themes span disciplines to build an integrated picture of the challenges and opportunities of buffer management in the GBE watershed. It is intended for practitioners familiar with the topic of buffers. Our goal is to capture the high-level findings and key take home points from the BOB project. This summary is not designed to provide a detailed synthesis of all the information covered by BOB, nor does it reiterate the full evidence base from which our conclusions are drawn. As such, we strongly encourage the reader to visit www.bufferoptionsnh.org and evaluate each of the BOB reports and maps individually.

Summary

The BOB project was driven by downward trends in key indicators of environmental health regularly measured in the GBE. These trends indicate an overall decline in the health of the GBE watershed as land conversion and human population growth have led to reduced habitat for wildlife and increased inputs of pollution, particularly non-point nutrients. Loss of natural habitat, particularly buffers, has also reduced the extent to which natural processes can help alleviate pollutant inputs before they impact freshwater and estuarine systems. While the extent to which the declining health of the GBE has directly impacted ecosystem services is not yet fully understood, evidence from other systems clearly shows that increased non-point pollutants leads to reduced water quality and affects related services such as provision of clean water for drinking and recreation. Importantly, we know that people in the GBE watershed, and in New Hampshire as a whole, value the provision of these services and are willing to invest resources to maintain and improve them: Previous statewide surveys have ranked water quality as the top environmental concern in New Hampshire, and the willingness to pay (WTP) meta-analyses undertaken for the BOB project reinforced and refined the likely value placed on this resource in the GBE watershed. Our synthesis of published ecological science relevant to the GBE watershed provides compelling evidence that buffers are an effective means of maintaining these valued services including water quality, wildlife habitat, and flood risk reduction. This science also provides specific recommendations for the widths and vegetative composition of buffers needed to maintain ecosystem services at a specified level.

Given this evidence base, i.e. the declining environmental health of the GBE linked to subsequent declines in ecosystem services that residents widely agree they care about, coupled with an effective tool (buffers) for addressing the challenge, this begs the question as to why there is not a greater focus on buffer conservation and/or restoration in the coastal watershed.

The answer to this question is found in the socio-economic analyses undertaken for the BOB project, which clearly demonstrate a suite of competing values and disincentives relating to buffer management. These analyses emphasize the importance of understanding the distribution of costs and benefits associated with maintaining buffers. A principle challenge is that the cost is primarily felt by the limited number of private landowners who own the buffered land; these landowners incur the potential costs associated with limitation of development potential or restriction in management for aesthetic appeal. Conversely, the benefits provided by buffers serve the populous at-large, including higher property values associated with better water quality, albeit with a decrease in this benefit for those living further from the resource. A similar decoupling of costs and benefits can occur when looking across communities. This is particularly true where a more tightly regulated community upstream provides water quality benefits to a downstream community with less regulation. This sense of “injustice” was also reflected in responses solicited from community members. The BOB economic analysis demonstrates that where these imbalances in costs and benefits occur, those with buffers may not be motivated to maintain them unless compelled by regulations or provided with an incentive, such as a conservation easement, that compensates for lost value.

The BOB community assessment, which was conducted in four towns in the Exeter-Squamscott watershed, brought to light the issue of competing values at the community scale. A common perspective shared by those interviewed for the BOB project was that there are inherent trade-offs between economic growth and buffer conservation, i.e. that one burgeons at the cost of the other. The theme of inherent trade-offs was also reflected in what were seen as competing community values, such as the provision of places for outdoor recreation and conservation of rural community character versus the maintenance of private property rights and augmentation of the tax base through development. As the preferred balance of these values varied among respondents, towns have the difficult task of integrating competing values in any local rules and regulations. They are not alone: A survey that tested the prevalence of findings from this assessment in the wider watershed found that 94.5 percent of respondents agreed that buffer-related decisions are inherently complex, requiring municipalities to balance many factors including property rights, community character, natural resource protection, abutters' concerns and economic growth.

These often-competing values and disincentives relating to buffer management are critical factors in driving existing regulation of buffers in the GBE watershed and the state. Compared to many other northeastern states, New Hampshire has a decentralized approach to wetland buffer regulation. Federal- and state-level regulations are combined under the oversight of the New Hampshire Department of Environmental Services. These regulations restrict certain land use activities within shorelands and wetland areas. However, extension of these regulations to encompass buffer areas is limited to water bodies defined under the Shoreland Water Quality Protection Act, water bodies designated as Prime Wetlands, and Tidal Buffer zones. If a stream or river is not designated or is less than fourth order, buffer protection is not mandated by the state. As such, state regulations represent the minimum protection that communities can rely on to preserve natural resources and the ecosystem services they support. This relatively limited scope of state regulations cedes control to municipalities, which can choose to enact more restrictive buffer regulations. Some have taken the initiative to provide additional protection, however, many have not.

The existing buffer regulations in New Hampshire therefore represent a compromise between a suite of competing values. As with any compromise, there are trade-offs, and it is unreasonable to expect any or all of the competing values to be met to their fullest desired extent. However, this does not mean that current approaches (both regulatory and non-regulatory) for protecting buffers in the GBE watershed are optimal; evidence from the BOB project suggests otherwise. From a resource protection perspective, the lack of state- or local community-regulated buffers for many streams and wetlands in the GBE watershed contributes to poor water quality and potentially a loss of other valuable ecosystem services. Where buffers are regulated, their width and/or regulated vegetative composition may not meet recommended standards for reducing nutrient loading or supporting wildlife habitat. From a community standpoint, ceding control to the individual towns has led to a confusing mosaic of differing regulations, challenges for communities that do not have the resources to develop or enforce local buffer regulations, and uncertainty regarding how such ordinances intersect with state and federal rules. From an economic perspective, mechanisms for addressing the issue of unequal distribution of buffer maintenance costs and benefits are not typically in place. Furthermore, navigating differences among local ordinances can pose a costly challenge both to private landowners and local developers.

Identifying options for addressing these concerns necessitates revisiting the lessons learned from each aspect of the BOB project, as well as looking beyond New Hampshire's borders. A logical first step, given evidence of inadequate buffering for water quality, is to look at recommendations from the scientific literature for appropriate buffer widths and the situations for which buffers are most important to maintain water quality. Given the wide range of factors that can vary spatially and temporally in natural and built environments, it is not too surprising that published science provides some nuance regarding the efficacy of any buffer. For example, different buffer widths may be needed to provide specific services at a given target level, and the extent to which a buffer can help promote a water quality target will be influenced by the amount of pollution ("loading") entering the system and site characteristics such as soil type and slope. There are several approaches to assigning buffer widths based on available science. Perhaps the simplest approach is to implement a single buffer width that should maintain the majority of ecosystem services under most circumstances. For this purpose, scientists tend to agree that a 100-foot wide buffer is a good target. Or, different buffer widths can be assigned to specific groups of identified resource values. An example of this type of approach is provided by the BOB project's prioritization maps, where we utilized 160-foot buffers for first- and second- order streams and their associated wetlands, 650-foot buffers for third-order and higher streams and their associated wetlands, and a 6-foot vertical buffer along with a 650-foot horizontal buffer for tidal areas. The most complex option involves assigning a buffer width based on fine-scale input factors such as slope, topography, pollutant loading, and soil type, allowing the buffer width to be tailored to site-specific circumstances.

Taking these scientifically-based buffer recommendations as a starting point, we can then consider how they intersect with our available socio-economic knowledge and how this informs regulatory and non-regulatory options to more effectively protect and restore buffer zones. From a regulatory standpoint, a solid case can be made for stronger statewide buffer regulations that encompass a wider range of riparian habitats in the GBE watershed and reduce the onus placed on local communities to develop and enforce their own suite of buffer regulations if they want to see these resources more fully protected. This case is built upon the scientific evidence of the inadequacy of current protection, evidence from the BOB policy analysis that the costs of local-level regulation outweigh the benefits, and support for statewide regulation expressed through our community assessment. However, any increase in statewide regulation will face barriers and come at costs. Strong state regulation is often seen as antithetical to the character of New Hampshire, thus there may be opposition to a proposed bill. Similarly, increased buffer regulation will almost certainly decrease the availability of land for development and agriculture, so these interest groups may also stand in opposition. For municipalities that have been progressive with buffer protection, there may be concerns that a statewide buffer policy would weaken their regulations.

Although it seems unlikely that increased state-regulated buffer policies can be enacted without shifting the balance towards resource protection and (at least in perception) away from maintenance of private property rights and less restrictive development opportunities, looking beyond New Hampshire's borders may provide models that fit with the character of the state and its regulatory environment. Of particular interest is the path that Rhode Island has recently followed in revising its buffer regulation. Rhode Island is a state that shares at least some key characteristics with New Hampshire: Polling conducted as a component of evaluation of Rhode Island's wetland rules showed that residents strongly value the protection of local communities' interests and ecosystems. However, respondents felt that the state's existing wetland regulation were in need of improvement to address challenges similar to those in New Hampshire, including inadequate protection of at-risk natural resources and lack of consistency among municipal regulations. In 2017, after a thorough analysis by a legislative task force, the decision was made to overhaul Rhode Island's decentralized wetland policies, placing the sole authority to regulate wetlands and buffers with state agencies. Municipalities are, however, still able to petition state agencies involved in buffer protection to increase protection of a certain resource above what is protected by the state. Currently, Rhode Island is considering an innovative tiered approach to buffer and setback regulations that considers various environmental attributes and divides the landscape into different regions. These classifications may be used to determine the buffer width enforced in a given area; this corresponds to the second approach to buffer width delineation described above.

While the regulatory path Rhode Island has followed may provide a framework worth considering in New Hampshire, if the only change made to managing buffers in the GBE watershed is increased state regulation, the issue of inadequate distribution of costs and benefits will not be addressed. There are a range of non-regulatory approaches that can help to more fully compensate private landowners for the economic cost of conserving and potentially restoring buffers. Conservation easements are an existing vehicle for compensating landowners for the cost of lost development potential. In New Hampshire, easements that include vegetated buffers are developed by both state agencies and non-governmental groups with public funding from sources such as the Natural Resources Conservation Service, the New Hampshire Land and Community Heritage Investment Program, and the Aquatic Resource Mitigation Fund administered by New Hampshire Department of Environmental Services. However, there is no statewide program in New Hampshire that specifically targets establishing easements for the purpose of maintaining buffers. A model for these targeted easements can be found in Vermont, which has established the incentives-based River Corridor Easement Program to purchase development and management rights from landowners for the portion of their property that falls within the meander belt of sensitive and erosive streams.

Easements offer an effective approach for protecting buffers in perpetuity, but establishing and monitoring easements is a costly endeavor and it seems unlikely that this vehicle can be used to protect enough buffers to be able to fully meet the needs of water quality protection and other key ecosystem services. There are other non-regulatory approaches that can be used to compensate landowners for lost value including offering tax credits or deductions. For example, King County in Washington State uses a point system to determine tax reductions based on maintenance of open space on private property. It is also possible to pair increased regulation of one natural resource with greater flexibility in managing another as a potential tool for achieving the desired outcomes of maintaining certain ecosystem services. For example, Maine has an approach for retaining larger buffers around vernal pools in exchange for allowing conversion of "less valuable" wetland resources.

In closing, a key deliverable from BOB was a menu of potential regulatory and non-regulatory options that could be used to effectively promote buffer protection and restoration in the GBE watershed. Due to the multifaceted approach taken by the project, we were able to provide wide-ranging guidance for this menu, spanning topics from ways to effectively frame and message buffer information with New Hampshire audiences, to ways to implement specific non-regulatory options for buffer management after taking into account lessons learned relevant to the character of New Hampshire from other states. Capturing the full breadth and critical nuance of this guidance is beyond the scope of this summary, but further information can be found at www.bufferoptionsnh.org. We hope this information assists in guiding those looking to increase the use of buffers as a tool for addressing issues related to water quality, wildlife habitat, and other critical ecosystem services in the GBE watershed.

AN INTEGRATED APPROACH:

SUMMARY OF THE GROUP PROCESS THAT SUPPORTED *BUFFER OPTIONS FOR THE BAY*

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A. Integrating From the Outset

The execution of an integrated assessment requires considerable investment in project management and coordination, and Buffer Options for the Bay (BOB) was no exception. From the project's outset, team leads found it important to clearly define roles, expectations, and a process for decision making; develop flexible work plans; allow for meaningful input and change; maintain consistent communication; and demonstrate how the project was evolving based on stakeholder and team engagement.

In meeting these objectives, BOB benefited greatly from having a primary investigator, engagement lead, and communications lead, all of whom are well versed in group process and facilitation. In addition, the project was extremely fortunate to have a team member who had additional time reserved to support project coordination as needed. Without this expertise or flexible resources, it is unlikely the BOB team would developed such complementary, useful products, nor would they have been able to create additional, opportunistic, products that could not have been anticipated in the proposal.

The project engaged approximately 40 participants from a diverse range of fields, sectors, and organizations. Each participant engaged in BOB as a member of one of three groups: 1) a large, interdisciplinary project team that included experts and end users and developed project products; 2) an active Advisory Committee (AC) which engaged additional end users, stakeholders and experts and offered input on project progress and products; and 3) a technical review panel that brought outside expertise to enhance the team's plans and final reports.

The team was further organized into sub-teams: technical, engagement, final products, and project management. Each of these had a lead and was responsible for different deliverables. The management team coordinated the efforts of the other sub-teams by holding periodic meetings with sub-team leads. They also managed grant reporting and planned full team and advisory committee meetings, and made decisions based on advisory committee input and when the full team did not agree on an issue. Sub-teams held frequent meetings and calls to advance their work and the full team met five times throughout the project.

B. Investing in Tools and Strategies for Group Process

Given the size of the team and the diverse perspectives held by team members, it was critical to develop consistent mechanisms for sharing information, identifying opportunities for collaboration, and handling feedback across sub-teams and with the advisory committee (AC). To meet these needs, the management team strove to find the "sweet spot" between investing too much or not enough resources in developing process support tools and strategies. To the extent possible, they tried to focus project resources on mechanisms that would facilitate cross discipline and cross sub-team engagement and keep team members tracked toward a collective vision.

With these criteria in mind, the project developed and used the following tools and strategies to support the project team's work:

- **Project team charter:** To establish clear project expectations and roles, the team used a collaboration charter (Appendix A) that laid out deliverables, a timeline that included meetings, expectations about workload, and decision making authority. At that first full team meeting, the group reviewed and confirmed the charter. They also reviewed the project proposal and assigned leads and teams to each deliverable. This was an excellent way to assess whether financial resources would be adequate to reach deliverables and clarify the point person for each piece of the project.

- **Work Breakdown Structures:** Each sub-team created a work breakdown structure (Appendix B) that described their work plans in detail. These plans allowed the sub-teams clarify their internal work process, timeline, and resources at the project outset and provided a way to share their intentions with project managers, the broader team, and the advisory committee. As a result, early on, the team members were able to identify decision points that depended on the input of the full team or advisory committee input, tasks that lacked sufficient resources, and opportunities to leverage each other's efforts. Work breakdown structures also were shared with the project's external review panel, which provided input to improve them.

- **Full team meeting agendas focused on integration:** Each full team meeting had a clear agenda built to encourage sub-teams to dig into each other's work and assist with decision points related to their deliverables (Appendix C). Sub-team leads had the opportunity to explain decisions, review the timeline and deliverables schedule, gather feedback from other sub-teams, and identify places where AC input would be helpful. Project management used the meetings to encourage the group to continually work toward a common vision for the final products.

- **Team newsletter**: In between meetings, project management circulated an internal newsletter (using mailchimp) that communicated key deadlines, meeting dates, and opportunities for feedback on sub-team work during the first 18 months of the project (Appendix D). This helped to reduce the "out of sight, out of mind" syndrome that can happen on long-term multi-component projects, affirm the common vision and goals, and connect people to relevant draft products, process tools, and other resources on the project's google drive.

C. Turning Road Blocks Into Opportunities for Team Cohesion

Collegiality and good will were built into the project design during proposal development. Project team and AC members all came from a professional network with a strong history of working together to serve communities and coastal decision makers in the Great Bay region. That said, confusion and disagreement are inevitable on an team composed on experts from diverse disciplines, working in different sectors for different organizations. The potential for this was compounded by the relative novelty of participating in a project that was focused on creating tools for the team members and advisory committee members. They were not creating the products for someone else; *they* were the project's end users.

Whenever possible, project managers tried to use confusion or disagreement as opportunities to build team cohesion. Here are three examples:

- Often, the team got "stuck" on a key vocabulary term. When necessary, project managers devoted full team meeting time to clarifying key definitions, for example a mutually agreed upon definition for buffers that all sub-teams could use to inform the scopes of their analyses. However, when the terminology was less central, or of more importance to those in a particular discipline, project managers reminded the team that they could adapt all of BOB's products to support their own work as needed. (*They were the end users.)*

- Often, team members wanted to identify and put forward a preferred option for buffer management, i.e, have a silver bullet they could roll out to communities. When this happened, project managers used it as an opportunity to remind the team that in an integrated assessment, the objective is not to find a single solution, but to integrate existing information from diverse fields in a compelling and easy to navigate way. When difficult issues like this occurred, project managers also solicited individual input through surveys or emails and then consolidated that into decision points for the entire group.

- Most of the BOB team and its advisory committee was composed of individuals who are committed to improving buffer protection and management in New Hampshire. It was inevitable that the collaboration of such a team would lead to ideas for action that exceeded BOB's resources and time frame. Project managers were able to channel these ideas into an action plan (Appendix E) that is encouraging the BOB team and its advisory committee to continue to collaborate to improve management of buffers beyond the life of the project. The plan also serves as a roadmap to the rich discussions and hard work that took place during this project to generate a shared vision for how we want to change what we do related to buffers moving forward.

  The action plan grew through each step of the collaborative process, as ideas were solicited (and naturally generated) from full team meetings, technical reviews, AC discussions, and public comments. By the last quarter of the project's timeline, there were more than 250 actions suggested. Project managers consolidated and organized the actions into discrete categories and brought it to the final AC meeting for review, refinement, and prioritization. This action plan reflects a collective commitment to use the findings of this IA.

D. Technical Review Process

The integrated assessment process required a review by an objective, external panel of experts to ensure that the credibility of the process and products associated with the project. In the absence of peer reviewed publications, this Integrated Assessment strove to make sure that the panel engaged experts outside of the project team and outside the region and that the panelists had the opportunity to give the team feedback on the approach and findings of the assessments. To support the review, the project managers and the external review lead created a

process and tools to ensure that the results would be as useful as possible to the sub-teams implementing the analyses, advisory committee members interested in the neutral opinions of outside experts, and the communications specialist developing the final products.

1. Methods

The team implemented a two-step process to ensure that helpful input could be incorporated as early as possible. The lead used the following criteria (informed by the full team and the advisory committee) to guide selection:

- People who are not involved in the project as stakeholders or project team members
- Reviewers could be from N.H. or other states
- People with one or more of the following kinds of expertise:
  - Knowledge of buffer issues (policy or biophysical) especially as relates to products we plan to deliver (e.g., policy analysis, GIS tools, etc.)
  - Communication expertise: Strong ability to communicate about buffer or related technical issues.
  - Predictive expertise: Puts a higher priority on ability to develop future scenarios and forecasts than on buffers per se
  - Implementation expertise: Skill and experience related to the practicality of applying new knowledge to resource management

Letters were mailed to potential reviewers and eight people were selected from across the country and across disciplines. A list of the technical reviewers and their affiliations can be found on the BOB website. The first review was conducted early in the project's second quarter to gather feedback that would influence approach and methods of each sub-team.

Each sub-team used a common template to create a three page summary based on the work plan breakdown completed in the first quarter of the project. (See appendix F) It included the focus of their analyses, method, sources, and a plan for what the analysis' final report would include. The template also asked sub-teams to highlight key choices or decisions (e.g., choices that must be made due to resource or information constraints or key assumptions or founding documents they would be building from). The summaries were first shared and discussed by the full project team and the advisory committee before being subject to external review.

Reviewers were asked for qualitative feedback on all of the five plans. Questions asked by the reviewers at this stage included:

1. *How might the "key features" be improved to increase probability of optimal success?*
2. *Are there other features/options that should have been considered?*
3. *Do you agree with the "key choices" made by the team?*
4. *Other General Comments that Could Help this Project Succeed?*

The next review occurred in the second quarter of second year. Reviewers looked at the draft geospatial products and draft reports (Community Assessment Findings, Coastal Science Literature Review, Economic Analysis, and Policy Analysis). This review focused on product credibility and that of the underpinning science. Panelists were also asked to assess whether the information presented in the reports was accurate and complete. Questions asked at this stage of review included:

1. Please choose your level of agreement with the following statement:

"The analysis is sufficiently credible (i.e., meets standards for technical adequacy) to support decision-making around riparian buffer management in the Great Bay Estuary Watershed."

To indicate your level of agreement, please bold or underline one of the following choices:

Strongly agree
Agree
Mixed
Disagree
Strongly Disagree

2. Please comment qualitatively on the credibility of the analysis. Please highlight key strengths and weaknesses. Please make suggestions on key citations, methods, case studies that, if included, would strengthen the analysis.

B. Results and how they were used

Technical review feedback was shared with sub-team leads and each was given a template to help process the input. The topic of buffer management is complex, there are gaps in social and biophysical science, and there are many policy questions that are unanswered in N.H. and around the country. In the first round of review, component leads were asked to look at the technical review and categorize the feedback into the following categories:

1) Feedback reinforced an approach we already planned to take
2) We will make a change based on this feedback
3) We may make a change based on this feedback
4) Not currently planning to make a change based on this feedback

Project managers summarized all of the component lead responses to these questions in a report that was shared with the full team and the advisory committee and used to adapt the methods. After the second round of feedback on draft products, component leads were given the following written guidance to handle technical reviewer responses:

1. *Make sure your report is credible: If the review came back and indicated that the report was "credible", all changes are optional. If the review indicated that the credibility was mixed or it was not credible, get in touch with the reviewer to see what changes are critical to get to credible.*

2. *Consider which recommendations to address in your report:*
   When conducting this step, please keep the following criteria in mind:

   - *Is the recommendation consistent with something we have already agreed is a high priority for us to address in year 2? See [this document](#) for the results of the last advisory committee. If the technical review repeats a priority, we should address it.*
   - *Is the recommendation a fairly straightforward edit or change that makes sense to you and is relatively easy to do? If yes, go ahead and make that change.*
   - *Is the recommendation a great idea that would require additional work or analysis that we were not planning on doing in year 2? If yes, please add it to the [action plan](#).*

3. Make sure to set up a meeting to get feedback right away if you are not sure what to do with a comment.

4. Make sure you add potential Action Items to the action plan

The feedback gathered at this stage directly fed into the work plans for year two of the project. The scope of some of the work changed to make sure credibility issues were addressed. Any ideas that were practical and relevant were incorporated into a rigorous discussion with the advisory committee about how time and resources should be allocated for the remainder of the project period. A prioritization exercise with the full team and AC resulted in three additional products in year two that were outside of the original scope of the grant, i.e, the economic literature review, the legal takings analysis, and social science bibliography. This was also an important stage in developing and refining action plan items. When an idea was clearly seen as critical to addressing buffer management, but was outside the scope of our Integrated Assessment grant, the idea was captured in our action plan.

E. BOB's Advisory Committee

1. Goals and Committee selection

BOB's Advisory Committee (AC) was created to solicit and incorporate feedback, ideas, and perspectives from a group of regional stakeholders who extended the knowledge and expertise beyond of the project team. The AC provided input on the following key milestones throughout the project:

1. Plans for the technical, policy, and community analyses
2. Selection of a sub-watershed and communities to work with
3. Prioritization of work done by project team members
4. Feedback on draft reports and mapping products
5. Plans for final products generated by the project
6. Generating and prioritizing the action plan.

Criteria for AC participation were developed by the project team and included the following:

- Knowledge of buffer work and/or of the Great Bay watershed
- Issue expertise (e.g., nutrient loading, flood attenuation, habitat, climate resilience, etc.)
- Community outreach, communications, and/or product-development expertise
- Social science expertise (e.g., conflict resolution, collaboration, institutional analysis)
- Awareness of the realities of implementing buffers (both the process of implementing buffers at the municipal level and the process of designing site plans for buffer projects)
- Awareness of approaches used in other places
- Federal agency perspective

The majority of AC members were consistent throughout the project. However, because the first part of the project included an analysis to select a sub-watershed for the community assessment, two new members from that sub-watershed were welcomed onto the AC about eight months into the project.

The majority of the advisory committee's work took place through four face to face meetings that lasted approximately 3.5 hours each. Planning for meetings was done by the project team leads; additional team members were brought into the planning when their skills or products were the focus of the meeting. Careful meeting design and facilitation plans were in place for each meeting, and included a process agenda with clear goals, interactive activities, and prompt notes and follow up actions. The team was engaged in determining how AC feedback would influence findings and products, and kept in touch with the AC between meetings via surveys and emails.

2. Advisory Committee work and how it was used

The project team was committed to meaningful engagement with the advisory committee. At the first AC meeting, which was attended by almost all project team members, the group reviewed

BOB's goals, timeline, a charter for the AC, and expectations for their workload. The AC was also asked for feedback on project work plans and the criteria used to select a sub-watershed for the community assessment. The suggested improvements or changes to the work plans were considered, along with the technical reviewer suggestions, through a structured template to help the team assess which suggestions were feasible, which ones were a good idea but the team needed help with, and which ones should be placed in the action plan. The criteria for sub-watershed selection were taken into account by the community assessment team, and are reflected in the methods below.

The second AC meeting focused on the draft reports. Each component lead created a summary of their draft report and developed key questions for the AC. These were shared with AC members before the meeting via survey monkey, which allowed them to submit detailed feedback on each report. Those results were processed by the Engagement team and project managers and presented and discussed at the "café style" meeting, in which where each AC member had a chance to offer more input on each draft report. This resulted in a list of specific things to improve or change and also provided clear direction on priorities that the team should try to address that were not in the products developed thus far. This included the addition of an economic literature review and the legal takings summary. This meeting also resulted in Advisory Committee members working together to submit a successful application to the NSC for a transfer project to address one of the barriers identified at this meeting (the lack of quantifiable metrics for pollutant removal for buffers).

Once the reports were underway, the AC was asked to help shape the mapping products and the website. At their third meeting, AC members were presented with three options for how the mapping products could be designed and served through the website. They discussed how they would use the maps, and how they would encourage others to use them, through hypothetical scenarios designed to help them envision realistic use cases. The results of this meeting were different from what the project team would have anticipated, and led to the creation of four pdf maps for each town plus a user guide for the state "Coastal Viewer" GIS platform.

The AC's input at this meeting also informed the design of the online framework that integrated all of BOB's findings and analyses. AC members were asked to think about questions that they have been asked, or questions they ask others about buffers in the course of their work. This led to a new approach for organizing the website in which each page was framed around questions. The final products sub-team mined each report to provide answers to these questions and then circulated a draft website for full team and AC review.

The last meeting of the AC refined and prioritized the action plan and provided input on which of aspects of the website needed further work and which would be available as downloadable "chunks" of information. This meeting resulted in a revised action plan with clear mutual priorities and a list of AC members interested in helping to make those things happen beyond the life of the project. The meeting also led to several changes to the website and a "launch plan" to ensure that partners in the area were aware of the project's results and had simple tools to help promote the website through their own organization's outreach channels. This included a short and long description of the project, a file of images and logos for use in promoting the work, and ready-made taglines for use in social media.

F. Community Assessment Methods

1.Community Assessment Goal

In New Hampshire, land use decisions involving buffer lands surrounding water bodies are often made by communities and individual landowners. These decisions are influenced by many factors, including local regulations and governance structures, prevailing culture, the community's economic and natural resources, and the often diverse perspectives of its citizens. Efforts at any scale to protect, restore, or manage buffers in support of water quality protection or other ecosystem services must keep these local considerations in mind if they are to succeed. To address this need, the BOB community engagement sub-team conducted an analysis of local factors influencing buffer-related decision-making in four communities in the Exeter-Squamscott sub-watershed and the relevance of these factors to communities throughout the wider Great Bay watershed. The goal was to help outreach, communication, and technical assistance efforts related to buffers become more targeted, relevant, and helpful for Great Bay communities and the practitioners who work with them on this issue. The results of this study can be found in the Community Assessment Final Report. This section focuses on the methods used to ensure that community input was fully incorporated into the products of this project.

2. Methods

Sub-watershed and Community Selection

Lacking resources to interview people from the 42 communities that surround Great Bay, the team developed a process to select a sub-watershed to focus this assessment on a few communities within that sub-watershed. With input from the project team and advisory committee members, the Engagement sub-team determined that the sub-watershed should include a group of communities that has the following characteristics:

- **Show differing levels of progress in terms of buffer-related regulations**, based on the 2015 PREPA report cards for shoreland protection and freshwater wetlands. Team members were interested in learning about the barriers faced by those communities making less headway (according to PREPA) and the successful experiences of the higher performing communities.

- **Include both MS4 (Municipal Separate Storm Sewer System) and non-MS4 communities (or those with a waiver).** The team wanted to understand whether there are differences in the perspectives, challenges, and opportunities related to buffers between communities that are regulated under this program and those that are not.

- **Are geographically diverse.** The team wanted to characterize differences in the perspectives, values, and opportunities between the more inland communities and those closer to the bay.

Based on these criteria, the Lamprey River and Exeter-Squamscott sub-watersheds rose to the top of the list. Based on a desktop GIS comparison, the technical team identified the Exeter-Squamscott, Oyster-Bellamy, and Winnicut River sub-watersheds as their top options given these have large areas that have been identified as important for salt marsh migration and significant opportunities for buffer protection or restoration adjacent to both tidal and freshwater riparian habitat. Ultimately, the Exeter-Squamscott sub-watershed was selected because of the overlap between criteria for community context and landscape scale, such as surrounding land use and conservation opportunities.

Table 1. Summary of Sub-watershed Assessment by Major Criteria

Sub-watershed	**# of towns**	**Major criteria**			
		Mixed levels of progress with shoreland protection?[1]	**Mixed levels of progress with freshwater wetlands?[1]**	**Mix of MS4 and non-MS4 communities? (2013)[2]**	**Geographic mix of communities, i.e., close to Great Bay and further inland?[3]**
Lamprey	12	Yes	Yes	Yes (2 MS4, 2 waiver, 3 non MS4)	Yes
Exeter-Squamscott	13	Yes	Yes	Yes (6 MS4, 5 waiver)	Yes

Coastal	8 (NH)	Yes	Mostly low levels of progress	Yes (3 MS4, 1 waiver)	No
Oyster-Bellamy	5	Yes	No	Yes (1 MS4, 2 waiver)	Some
Hampton-Seabrook	5	Mostly low	Mostly low	Yes (2 MS4, 1 waiver)	No
Salmon Falls	7 (NH)	No	Mostly low	Yes (2 MS4, 3 non)	Yes
Winnicut	3	No	No	No (2 MS4)	No

1. Piscataqua Region Estuaries Program, 2015 Piscataqua Region Environmental Planning Assessment, http://prepestuaries.org/prepa/
2. Information retrieved from: https://www3.epa.gov/region1/npdes/stormwater/nh.html
3. Based on a visual assessment

The Engagement sub-team analyzed characteristics of communities within the Exeter-Squamscott sub-watershed to identify three or four towns for the analysis. Considerations included where technical assistance had been dedicated in the past on buffers, population density, per capita income, impaired waters, type of drinking water source, presence of a watershed committee, and presence of important agricultural soils. The goal was to identify communities with enough diversity to capture commonalities and unique attitudes and approaches to buffer management. This analysis is summarized in Table 2, and resulted in the selection of four communities.

Table 2. Additional Criteria to Inform the Selection of Focal Communities within the Exeter-Squamscott Sub-watershed

Exeter-Squamscott sub-watershed	**PREPA 2015: Shorelands**[1]	**PREPA 2015: Freshwater Wetlands 1**	**MS4 Mix**[2]	**Geographic mix**[3]	**Pop. density** (people per sq. mi)[4]	**Per capita income**[4]	**Impaired waters**[5]	Exeter River as drinking water supply?[6]
Brentwood	45	17	Waiver	Inland	267.2	$37,506	Yes (AL)	
Chester	25	33	Waiver	Inland	184	$39,816		
Danville	5	0	Yes	Inland	378.5	$31,443		
East Kingston	20	0	Waiver	Inland	250.5	$39,366		
Exeter	75	50	Yes	Inland/close to Great Bay	728.1	$37,972	Yes (AL, PCR)	Yes

Fremont	75	50	Waiver	Inland	250.5	$36,331	Yes (AL)	
Kensington	5	0	Yes	Inland	175.8	$49,435		
Kingston	55	100	Yes	Inland	305.1	$37,266		
Newfields	50	0	Waiver	On GB	230.5	$50,700		
Newmarket*	20	50	Yes	On GB	710	$32,244	Yes, Lamprey – AL, PCR, SF, FC)	No (Lamprey)
Raymond*	0	0	Yes	Inland	353.2	$27,755	Yes (AL)	
Sandown	0	17	Yes	Inland	434	$37,507	Yes (AL)	
Stratham	20	0	Yes	On GB	481.8	$56,550	Yes (AL, PCR, FC, SF)	

1. Piscataqua Region Estuaries Program, *Piscataqua Region Environmental Planning Assessment 2015*, *http://prepestuaries.org/prepa/*
2. Information retrieved from: https://www3.epa.gov/region1/npdes/stormwater/nh.html.
3. Based on a visual assessment.
4. From 2015 Community Profiles, Economic and Labor Market Information Bureau, NH Employment Security.
5. From NHDES 2014 draft list of threatened or impaired waters that require a TMDL (10/14/15); Aquatic Life (AL), Primary Contact Recreation (PCR), Shellfishing (SF), Fish Consumption (FC).
6. From NHDES Drinking Water Source Assessment Program: retrieved from: http://des.nh.gov/organization/divisions/water/dwgb/dwspp/reports/index.htm

The four highlighted municipalities are those selected for the focus of the community assessment.

* = Addition to PREPA's list of communities in the sub-watershed.

Once the focal sub-watershed and communities were selected, the team compiled resources specific to the sub-watershed and municipalities. These resources were used to develop profiles that summarized the communities' approaches to buffers and prepare for the interviews. In addition, the Engagement team assessed the four communities' ordinances by comparing to the PREPA report and New Hampshire Department of Environmental Services (NHDES) model ordinances. The team developed a simple inventory of the municipalities' shoreland and wetland buffers. Since specific ordinances are complicated and difficult to compare to each other, these were grouped into three general categories: 1) no cut-no disturbance buffer, 2) limited cut or managed buffer, and 3) no buffer and captured the width of the buffer. This did not include setbacks. With the sub-watershed and communities selected and background research complete, the Engagement team reached out to contacts in Exeter, Stratham, Freemont and Chester and started the interview process.

Interview and Analysis Process

Identifying interviewees

The Engagement team visited the four town halls to introduce the project and establish initial connections. Initial points of contact were asked for suggestions for municipal representatives (staff and board members) whom we should interview about buffers. The team reached out to these stakeholders via email to describe the project and the interview. Interviews were conducted with 38 stakeholders to gain a more in-depth understanding of the buffer-related decision-making process at the local level, perspectives and preferences, and challenges and opportunities related to both regulatory and nonregulatory approaches, as well as implementation. During each interview, the interviewer asked for suggestions for further interviewees and continued this process. In addition to the municipal representatives, other stakeholders were interviewed who are involved with buffer-related decisions in their work and have familiarity with the focal towns. These stakeholders included engineers, wetland scientists, planners, and developers.

Table 3: Distribution of Interviewee Roles

13 Municipal staff:	**10 Municipal board members:**	**15 Other stakeholders:**
• 4 Code enforcement officers • 4 Planners • 3 Town administrators or managers • 2 Other	• 4 Conservation commission members • 2 Planning board members • 2 Zoning board members • 2 Select board members	• 4 Engineers • 2 Wetland scientists • 3 Developers • 4 Regional planners • 2 Other outreach and technical assistance providers

Interviewees: Demographic Information (not self-reported)
11 female, 28 male 100% Caucasian

The team continued the interviews until they got a sense of triangulation and suggestions for additional interviewees were redundant. In total, 38 individuals were interviewed in 28 interviews (some interviews included multiple individuals).

Interview Approach

A list of questions guided the interviews based on the work plan and subsequent feedback from the project team, advisory committee, and external technical review panel. The interviews were generally semi-structured, with some falling more into the unstructured category. Each interview began with an overview of the project, the purpose of the interview, a description of how the information would be used, and a request for permission to record. Recording enabled the interviewers to fully participate in the interview, and transcribe later. All but two interviews were recorded.

Two team members conducted most interviews together, though nine were conducted with one team member. Most interviews were with one person to try to ensure he or she was comfortable describing his or her perspectives. However, there were several instances with two, three, or four interviewees in the same conversation. The team agreed to this to be respectful of their time, to engage as many people as possible, and to accommodate their preferences.

The questions varied depending on the interviewee's role, since their involvement with buffer-related decisions varied; for example, some were conservation commission members, while others were engineers. The conversation adapted to include particular questions we had about the municipality the interviewee represented, including, for example, specific questions about the town's zoning ordinance. The interviews were structured to allow the interviewee to discuss the ideas, issues, and stories that came to mind. The interviewees asked follow up questions when necessary. Conversations ranged from about 45 minutes to more than two hours, though typically they were in the 90-minute range. Questions typically asked of the municipal and consultant interviewees included:

Questions for municipal stakeholders (staff and board members):

1. How long have you lived in this community?
2. How long have you been in your current role for the town, and have you served on any other boards or committees in the past?
3. How would you describe Stratham, what would you say are the major values or characteristics that are important to the town? Have there been any changes over time?
4. What does the decision-making process look like when you get an application that impacts the buffer? Could you walk us through the process, i.e, who's involved, what are the steps, what are the questions that you ask? What is your role in the process?

5. Confirmed our understanding of the Zoning Ordinance components related to buffers, then asked if there are any other components that relate to buffers.
6. How well do you feel the current regulatory framework is working? What works well, and what doesn't?
7. What are the major challenges to implementing buffers?
8. What could be improved (in the ordinance or implementation)?
9. Are there any non-regulatory approaches (like incentives) that you think might work here?
10. Are there any resources (information, content or mechanism, funding, training, assistance, etc.) that would be helpful in improving buffer management?
11. Stratham is on the most recent list for MS4 regulated communities—is there any consideration of buffers in relation to meeting these permit requirements?
12. Is there anything else you'd like to share?
13. Who else should we talk to?

Questions for other stakeholders (engineers, wetland scientists, etc.):

1. What is your professional role? How long have you been doing this kind of work?
2. What is the geographic scope of your work?
3. What types of clients do you work with?
4. Can you describe for us what a typical project looks like and what your involvement is?
5. Do you have any experiences with Chester, Exeter, Fremont, or Stratham?
6. Have you noticed any differences in terms of how buffers are managed or how these decisions are made in different communities? If so, have you noticed any factors that contribute to successful buffer management or good decision-making processes?
7. Do you have any perspectives about the buffer management options that communities in this area tend to employ (what works well/what doesn't)?
8. Have you noticed any changes over time (in approaches to managing buffers, decision-making process, etc.)?
9. Do you deal with the state regulatory framework in your work? If so, is it challenging to navigate the overlap between municipal and state processes? Are there any opportunities for improvement there?
10. What are some of the perspectives or concerns about buffers that you hear from clients/stakeholders?
11. What are the challenges related to buffers in your work? What do you think could be improved? (e.g., buffers would work better if communities had ____ resources or capacity, or if municipal board members had training in ____)
12. Are there resources related to buffers that would be helpful in your work?
13. Is there anything else you'd like to share?
14. Who else should we talk to?

Recordings were uploaded to a computer and named using a standard filing system. Transcriptions were shared between a limited number of project team members through a shared Google Drive folder. Care was taken to protect interviewees' confidentiality. The initial analysis of the transcripts was done by team members who did not conduct the interviews, to provide a degree of separation between the findings and the source.

Analysis Process

The analysis process was informed by Grounded Theory methods for qualitative research (Birks and Mills, 2011; Charmaz 2006; Corbin and Strauss, 2015; Goulding 2002; and Houle 2015). A memo was prepared for each interview by reviewing the transcript and any notes from the interview then writing a summary of the key themes, capturing demonstrative quotes where useful, and recording reflections and insights where they arose. Through an iterative process of condensing these memos, a spreadsheet was developed of all of the ideas from each memo, maintaining the identifying interviewee number as well as the category identifying the type of stakeholder. In order to keep some distance between the specific interviewee and the findings, the findings were grouped by the following categories:

Internal (within a municipality)

- Professional (e.g., staff)
- Volunteer (e.g., unpaid board members)

External (not within a specific municipality)

- Professional (e.g., wetland scientist, engineer, developer, planner, etc.)

The Engagement team convened to discuss the findings, using post-it notes with each idea from the memos, with those from "internal" interviewees color-coded to identify the associated community. The team grouped similar ideas and continued until all ideas were assigned a category. "Internal" interviewees' ideas were color coded first, and then the "external" interviewees' ideas. For the external interviewees, we did not force the same categories from the internal round, but many of the same categories emerged. After all of the post-it notes were sorted, the team created a spreadsheet compiling the results of the categorization. From there, the team worked through each category, condensing like ideas and describing higher-level themes. A summary of the key themes from the interviews emerged, and the team created a draft report. The draft was sent to all of the interviewees for verification, and then reviewed along with other draft reports by the full team, AC and technical reviewers.

Approach: Testing Sub-watershed-level Results for Broader Relevance

Purpose of the Watershed-Wide Vetting survey

The Community Assessment (CA) is based on interviews with municipal board members and staff, as well as other stakeholders, in four municipalities in the Squamscott/Exeter sub-watershed of the Great Bay watershed. The project team vetted those results throughout the larger Great Bay watershed of 42 municipalities through an online survey. The survey was developed to find out the extent to which the findings of the Buffer Options for the Bay (BOB) Community Assessment are representative of all the Great Bay municipalities, to see if the key findings broadly hold true, and to find out if there were key issues regarding buffers that are not captured in the CA.

Survey Audience

The survey was emailed to individuals on the Great Bay National Estuarine Research Reserve Coastal Training Program's town-specific contact list of municipal officials (including Select Board or City Council members, Planning Board, Conservation Commission, Zoning Board, Department of Public Works, Code Enforcement, and town administrators). In the introductory email, participants were asked to forward the email to peers, and the survey was sent out through several partners' email contact lists as well (N.H. Association of Conservation Commissions, Piscataqua Region Estuaries Partnership, UNH Cooperative Extension). The survey was open for 2.5 weeks, and 73 completed surveys were received.

Survey Details

Participants were asked to answer 25 questions based on their experiences and what they have directly witnessed or experienced in their town regarding buffers and buffer perspectives. Twenty of the survey questions were multiple choice with three simple options (yes, no, not that I recall), asking whether the buffer perspective (from the CA findings) presented in the question had been witnessed or experienced in the respondent's community. Three questions were open-ended questions, and the last two questions asked for individuals' roles and communities they represent. The survey was designed to take less than ten minutes to complete, and the average time to complete the survey was ten minutes and seven seconds. The survey confirmed that many of the findings in the Exeter-Squamscott communities were true for other municipal representatives throughout the watershed. Detailed survey results can be found in the Community Assessment findings.

Table 4: Key Findings from the Watershed wide survey

C. How results of the Community Assessment were integrated into the project

The Community Assessment was both a stakeholder engagement strategy and a stand-alone product for this project. The findings will be useful for other technical assistance organizations seeking to understand community perspectives on land use ordinance decisions, and serves as a comprehensive Needs Assessment for GBNERR's continued work on the topic of buffers. This work also directly influenced the way this project progressed. Community needs that were articulated in the CA were taken up as priority discussion points by the project team and Advisory Committee. The Engagement team developed a model for working with communities on buffer management and protection that is based on establishing trust and acknowledging the community context. This model was also used by the team as a way to think about how to approach the structure of the website and some of the downloadable graphics and two-page summaries that are on the website.

G. Public Comment

Consistent with the guidance for Integrated Assessments, this project held two public meetings to gather comments on the project. These meetings took place on February 28th at the Hugh Gregg Conservation Center in Greenland, N.H. The Great Bay National Estuarine Research Reserve holds a winter series of lunchtime talks that are relevant to Great Bay. This project was highlighted at one of the "Lunch and Learn" sessions and the time was structured to walk through the project and results and to solicit public input. The team held another public input session on the same date in the early evening, to ensure that working professionals could also attend. The events were publicized using our website, facebook page, and the Great Bay Stewards (official non-profit partner to GBNERR) newsletter. The following table summarizes the questions that were asked, and the responses given:

What assistance did the Univ. of Michigan provide?	Funding, assistance in understanding how to do an Integrated Assessment, development of communication products, connecting us to other research teams doing similar work, etc.
What kind of grants are available for communities to work on buffers?	Resources can be found on the BOB website under "Resources"
Did you consider oil spills both major spills as well as oil/gas/transmission fluid off of roadways?	Oil spills were not considered during this project
Did you get feedback from developers in the Community Assessment?	Some developers were interviewed as a part of the Community Assessment, but there are also several actions related to working with developers and realtors in the Action Plan.
Do you have a practical "how to plant" a buffer on the website?	There is a planting plan that was developed for the city of Portsmouth in the resources section of the website. The working with landowners section of the website is an opportunity for additional work, and we hope to be able to expand that in the future.

Did you consider future land use and Sea Level Rise and salt marsh migration in your work?	Yes, salt marsh migration is built into the wildlife maps and the flooding maps.
Have you considered targeting professional landscape contractors for outreach and education workshops on buffers?	This is in the Action Plan, and we will make sure we work to promote this in the future.
How does the NH State Comprehensive Shoreland Protection Act come into play here, doesn't that cover all water bodies with a buffer?	The Shoreline Water Quality Protection Act does not cover all stream orders, it only covers larger water bodies, prime wetlands and higher order streams and rivers.
Everyone is for water quality protection until it affects what they want to do on their land. How do you handle this?	It all starts with values, we hope that when people understand the value of buffers these decisions can be researched and evaluated with a combination of good science, and an acknowledgement of what a community or individual values.
Not every water body is created equal; I am worried the information on the site will be used to protect a low spot or a wetland of no value. Regulations need to be based on functions and values of wetlands and water bodies; you should not regulate people's properties.	In this project, variable width buffers are not considered in relation to the quality of the waterbody, it is in relation to the site characteristics (like soils or slope).
Did you have an examination of variances in the Community Assessment?	The website links to the PREPA, an analysis done every five years by the Piscataqua Regional Estuaries Partnership.
Asking for the web address.	Bufferoptionsnh.org
How would I use this information in my town?	We hope the information will be used to increase capacity to do three things: inform any town ordinances or planning you are doing; help prioritize opportunities for land protection; help prioritize opportunities for restoration on town owned land.
What were the criteria for the maps?	The maps were created from pre-existing layers that are the results of modeling efforts done in association with either the Wildlife Action Plan or the recent Water Resource Analysis done by TNC. Pete Steckler was involved in both of these modeling efforts and metadata is available on the Coastal Viewer.

Does the economic analysis include the value of the waterbody?	No, the economic analysis is a benefit transfer study that created a NH Specific function to determine what people would be willing to pay for an increase in water quality. For details, please see the Economic Analysis report on the website.
A semantics question regarding the use of nitrogen, related to fresh and salt water pollution, in salt water nitrogen would be the major concern in fresh water it would be phosphorus, so perhaps use the words nutrients and other pollution.	Thank you, we will take a look at that on the website and see if we can make some quick edits.
How will we interact with other projects in the action plan regarding agriculture and or forestry?	Great question, we have some contacts in the forestry and agriculture work in NH, but we should do more. We will add to the Action Plan
As we use this information is there a way for the BOB team to monitor its use and track how the information is used and if it is successful?	There is not a plan to do this now, but we are planning on tracking the Action Plan that was developed. We also have plans to work with PREP to see if the town level ordinances change, etc.
Can we track downloads from the website?	I will ask our communications lead.
Is there an overlap with a watershed master plan?	We hope these results will be incorporated with future watershed master plans, and would be happy to work with people to see how current plans align.
What is in the BOB non-regulatory approaches? There may be some models to look at with Carbon Offsets that might be helpful.	Conservation, tax incentives, restoration funding opportunities. We would like to continue building out this section of the website, thank you.
Is there a cross over with Jane Ballard's work on ecosystems services?	Yes, we have made sure Jane is aware of this work and we think her basic awareness building about ecosystem functions and values will provide a nice context for discussing buffers.

Buffer Options for the Bay Team Charter

VERSION 1, LAST UPDATED ON 10/28/2015

I. Project Overview
The goal of the Buffer Options for the Bay (BOB) project is to enhance stakeholder capacity to make informed decisions related to the protection and restoration of buffers around New Hampshire's Great Bay. To this end, this project will conduct an integrated assessment that combines, interprets, and communicates science-based information focused on the following policy question: *What are the regulatory and non-regulatory options for addressing the challenges to effectively protecting and restoring buffer zones around New Hampshire's Great Bay?*

The project team is composed, in large part, by representatives of organizations that intend to use the project's outcomes and products. To ensure this project is useful to a broader range of stakeholders, the team is engaging an Advisory Committee to provide input on the project's approach, its progress, and the design of its ultimate products. The team will also receive feedback from a technical review panel composed of experts in policy, biophysical science, science translation, communications, and predictive scenarios and forecasts related to buffers.

II. Purpose of the Charter
This charter describes the purpose, structure, and operations of the Project Team. It is intended to serve as a living document to be modified by the Team as needed throughout the project and a procedural guide that describes how the Team will commit to interacting with each other, the Advisory Committee, and in response to Technical Panel Review.

III. Project team structure, membership, roles, and milestones

A. Management team: The Management Team will provide leadership and coordination for the project and its milestones. It will be coordinated by Cory Riley, GBNERR, and includes Steve Miller, GBNERR; David Patrick, NHTNC; Dolores Leonard, ROCA Communications+; Lisa Graichen, GBNERR; Kalle Matso, PREP. This group is responsible for the following milestones:

- Fiscal administration and technical team coordination: David
- Engagement team coordination: Steve & Lisa
- Technical review: Kalle
- Full team coordination & communications: Dolores & Lisa
- Early, mid, and end stage communications products: Dolores
- Implementation plan: Cory
- Integrated Assessment report: Cory & Dolores

B. The Technical Team is responsible for reaching the milestones described below. It will be coordinated by David Patrick, NHTNC, and includes Paul Stacey, GBNERR; Rachel Stevens, GBNERR; Peter Steckler, NHTNC; Robert Johnston, George Perkins Marsh Institute & Clark University; Dana Bauer, Clark University; Thomas Ballestero, UNHSC; James Houle, UNHSC

- Literature review: David with full team input and individual investigator support as needed.
- Watershed scale analysis: David, Pete, Rachel, Tom
- Economic meta-analysis and model focused on water quality: Rob & Dana

C. The Engagement Team is responsible for the milestones described below. It will be coordinated by Steve Miller, GBNERR, and includes Lisa Graichen, GBNERR; James Houle, UNHSC; Kalle Matso, PREP; and Michele Holt Shannon, NH Listens.

- Advisory committee formation and engagement: Steve & Lisa
- Subwatershed selection process: Steve & Jamie
- Community assessment: Steve, Lisa, & Michele
- Buffer management option weighting process: Steve, Kalle, Cory

D. End User Representatives: While the majority of the Project Team is composed of intended users of the final products of this project, a specific subset of these are responsible for the policy analysis that will explore the regulatory and non-regulatory options for buffer management in New Hampshire and other states. Members of this group include Simone Barley-Greenfield, Coastal Fellow with NHDES, Steve Couture, NHDES Coastal Program; Mary Ann Tilton, NHDES; Sandy Crystall, NHDES; and Cory Riley, GBNERR.

IV. Team Communication

A. Meetings

- **Full team meetings**: There will be up to five, face-to-face meetings between November 9, 2015 and September 30, 2017. These meetings will be up to 5 hours in length, with two hours devoted to full team discussion and up to 3 hours devoted to small group work. All meetings will be held in locations convenient for the majority of the team and virtual participation will be made available upon request when possible.

  Full-team discussion will be organized by the project management team; subsequent small group work will be organized by component leads. In preparation for (or as a result of) these meetings, team members may be asked to present their plans, progress and requests for full team input, review documents, offer opinions, or consult individually or in smaller groups with other project team members.

  Meeting minutes will be drafted by Lisa Graichen and the full team will have the opportunity for review before they become part of the project record. Each meeting will end with a brief, informal evaluation and/or dialogue to ensure that team members feel that their time is used wisely.*

**After the November 9 meeting, the team will confirm whether this approach to full team meetings is effective and necessary and confirm dates for subsequent meetings.*

- **Subgroup meetings**: These will be organized by component leads, in accordance to the needs and availability of participating investigators as they work toward the milestones under their responsibility. Their frequency will depend on the subgroup's need for communication in support of reaching milestones. Component leads will work with Cory and Dolores to ensure that agendas for meetings with their subgroups and full team meetings are integrated and as productive as possible in advancing work toward specific milestones.

B. Ongoing communication

- **Full team updates:** The management team will use the "What About Bob?" e-newsletter to keep all team members up to date with overall project progress, information needs and plan changes from various components, meeting dates, etc. The newsletter will come out at least twice a month or more frequently if needed. All documents relevant to requests for input will be linked to this newsletter.

- **Sharing and creating documents:** The management team will use Google Drive to create, store, and share documents for this projects. All team members need to be comfortable with this platform; if anyone finds it is challenging to use, Dolores will provide technical assistance. Folders for Google Drive will be kept up to date by component leads and organized according to the project's major milestone's and functions:

    - Full team resources
    - Project management
    - Watershed scale analysis
    - Advisory committee
    - Community assessment
    - Literature review
    - Weighting criteria
    - Policy analysis
    - Technical review
    - Final products

IV. Operating Protocols

A. General Principles of Collaboration

Using the following principles of collaboration, the Project Team agrees to:

- Commit to spending the time, energy, and organizational resources necessary to meet project objectives;
- Recognize the validity of differing points of view;
- Recognize the complexity involved in buffer-related issues;
- Be prepared to listen intently to understand others' views;
- Regard disagreements as problems to be solved, not battles to be won.

B. Decision Making
BOB is a two-year project with many, moving parts and tight deadlines. Each of the project's key milestones is, in some way, interdependent and subject to review by the Advisory Committee and the Technical Review Panel. For this project to succeed, it is critical for all team members to respond to calls for input in a timely fashion or to be content with decisions made by investigators responsible for specific milestones.

With that understanding, all Team members will strive for consensus as they implement and adapt their work toward accomplishing the milestones under their responsibility. However, taking a consensus-based approach does not mean that complete, enthusiastic support for every decision will be required to move forward. It does mean that deliberate effort will be made to inform the full Team of progress and need for input and that opposing points of view will be respectfully worked through thoroughly to identify potential areas of agreement.

C. Conflict Resolution
Should disagreement arise among Project Team members (e.g., over data sources to include or interpretation or project outputs) the group will strive to first resolve the disagreement internally. Should conflict remain, Cory Riley and Dolores Leonard will support the Team in documenting dissenting opinions and presenting them in tandem with the group recommendations.

Engagement Team: Community Assessment Overview and Work Breakdown Structure

Why are we doing this?

The community assessment will help us better understand the barriers, opportunities, values, perspectives, and social/political context related to buffer management. By focusing on 2-4 communities within one subwatershed, we aim to get an in-depth understanding of the context for buffer-related decisions at the local level. This component will yield a summary report and will feed into the "clarifying the issue" synthesis. The results will also inform the option evaluation stage, as we will have an improved understanding of what may or may not work in certain communities and why.

How will we do it?

Once the subwatershed and communities have been selected, we will reach out to members of the communities (e.g., municipal officials or other contacts we might have) to invite them to participate. We will use the following methods in the community assessment:

- Review existing resources (e.g., master plans and newspapers) and identify existing community groups (e.g., a local watershed group)
- Observe community meetings (e.g., conservation commission and planning board meetings) and review meeting minutes
- Conduct interviews and surveys
- Conduct focus groups
- Employ stakeholder mapping methods (e.g., Susan Clark's *Policy Process*)

We anticipate engaging municipal officials and board members (e.g., selectmen, planning board members, conservation commission members, etc.), as well as individuals involved with local watershed or conservation organizations, developers, consultants, and other stakeholders as needed. We will use stakeholder mapping to identify the community members involved with and/or affected by buffer-related decisions and guide our investigation into their knowledge, attitudes, perspectives, and values.

Steps and timing (see WBS below for more details)

1) Develop community assessment plan and get project team and AC feedback. (Sept. 2015 – Jan. 2016)
2) Once subwatershed and communities have been chosen, refine the assessment plan as needed and compile resources specific to those towns. (Jan. – Feb. 2016)
3) Implement the community assessment plan in each community, documenting findings and lessons learned along the way. Methods will include review of existing resources (e.g., master plans); observing relevant community meetings (e.g., conservation commission meetings); conducting surveys and interviews with municipal officials, landowners, and other stakeholders; and conducting two focus groups in each community. Share progress with team as needed. (Feb. – April 2016)
4) Analyze results, draft community assessment report, and share with project team and AC. Incorporate findings with development of final products. (May – Sept. 2016)
5) Follow up with communities to share results of project. (Sept. 2017?)

Progress to Date

- Drafted community assessment plan; presented to project team 11/9

- Developed criteria for subwatershed/community selection, within input from some project team members at 11/9 meeting; started evaluating subwatersheds against those criteria

Next Steps

- Continue to prep for implementation
- Get feedback from AC on community assessment plan and subwatershed/community selection criteria/recommendations (January 2016)
- Refine plan once subwatershed and communities are selected
- Invite representatives from the subwatershed/communities to join the Advisory Committee once selected

COMMUNITY ASSESSMENT: work breakdown structure	
1. Framing	**1.1 Develop Community Assessment Plan** ● Draft plan, get feedback from project team (11/9) and AC (1/13); revise as needed ● Develop materials for surveys, interviews, and focus groups, and guidance for meeting observation ● Invite communities and refine plan based on subwatershed/communities selected ➢ **Level of effort and timing:** 20 hours; September 2015 – January 2016 ➢ **Responsible:** Steve and Lisa, with input from Michele and Jamie ➢ **Dependencies on other parts of project:** Feedback from project team members on the plan **1.2 Select Subwatershed and Communities** ● (See subwatershed selection WBS for more details) ➢ **Level of effort and timing:** 40 hours; October 2015 – January 2016 ➢ **Responsible:** Steve and Lisa, with input from Jamie (Diffusion of Innovation) and other project team members ➢ **Dependences on other parts of project:** Ideally some input from the GIS work about the opportunities for greatest impact

2. Doing	**2.1 Implement Community Assessment Plan** ● Compile existing resources for the communities selected ● Begin stakeholder mapping for the communities to identify specific community members that need to be engaged and set up the framework for investigating their perspectives, values, etc. ● Determine which community meetings will be relevant to attend and find out schedule/contacts; collect past meeting minutes ● Conduct interviews, surveys, and focus groups ● Compile/organize data, document lessons learned, share progress with team ➢ **Level of effort and timing:** 200 hours? January – February 2016 review existing resources and prep for engagement in communities; March – April 2016 conduct interviews/surveys/focus groups ➢ **Responsible:** Steve and Lisa, with support from Michele on focus groups ➢ **Dependencies on other parts of project:** May need some information/resources from the literature review and mapping work to use in community meetings **2.2 Analyze Results and Develop Report** ● Analyze existing resources, survey data, interview transcripts/notes, focus group notes/products, meeting observation notes, etc. ● Draft Community Assessment report ➢ **Level of effort and timing:** 20 hours; May through August 2016 ➢ **Responsible:** Lisa and Steve ➢ **Dependencies on other parts of project:** Just staying up to date with other components' progress and results to ensure our analysis and reporting is most relevant and useful to the project team

3. Wrapping Up	**3.1 Share Findings/Report with Project Team and Advisory Committee** ● Share draft report and findings with project team and discuss integration with other project components ● Present findings at September 2016 AC meeting (preliminary results conference) ● Revise report based on feedback ➢ **Level of effort and timing:** 5 hours; August – September 2016 ➢ **Responsible:** Lisa and Steve ➢ **Dependencies on other parts of project:** Just staying up to date with other components' progress and results to ensure our presentation of findings is **3.2 Integrate Community Assessment Findings with Evaluation of Options Process and Development of Final Products** ● Make sure relevant findings from Community Assessment inform the process of evaluating options with the Advisory Committee and the development of final products ➢ **Level of effort and timing:** 5 hours; September 2016 – July? 2017 ➢ **Responsible:** Lisa and Steve, collaborating with Dolores on final products ➢ **Dependencies on other parts of project:** Overlaps with the Advisory Committee work (Steve and Lisa also responsible) and with the product development work (Dolores and Cory) **3.3 Determine Appropriate Follow-up with Communities Involved** ● This could be another meeting to present the results of the Community Assessment (i.e., September 2016), or the results of the whole project (September 2017) ➢ **Level of effort and timing:** TBD ➢ **Responsible:** Lisa and Steve ➢ **Dependencies on other parts of project:** May want some participation from other project team members at these follow-up presentations

What: Buffer Options for the Bay Full Team Meeting
When: Tuesday, December 13, 9:00 a.m. to 1:00 p.m.
Where: Hugh Gregg Coastal Conservation Center, GBNERR
Who to call if running late, etc.: Dolores @603/289-9442

Objectives:

- Bring full team up to speed on project timeline, product development, etc.
- Capture ideas on next steps regarding survey and AC input to complete interim reports
- Prioritize and begin work plan for year 2, beyond interim reports

Agenda

9:00 a.m.

- **Orientation (Cory)** Context and timeline overview: what do we need done by 1/15 and how will we work together after that? What resources and time do we have to complete our work? When was the last time you saw Scrooged? (Trivia alert!)
- **Economic analysis update (Dana)** Overview of approach and introduction to water quality indices
- **Community assessment update (Lisa)** Brief update on community assessment analysis work
- **Lightning round (Depends)** Opportunity to get quick input to inform completion of interim reports/products. Five minutes per question.

10:30 a.m.

- **Prioritization round (Cory):** team reviews and prioritizes advisory committee suggestions from survey and recent meeting to see where we want to invest our time and resources after 2017
- **Group discussions:**
  —Addressing variable width buffers (Shea and David)
  —Cross-walking policy analysis and literature review (Cory)
  —3rd topic TBD from prioritization discussion

12:15 p.m.

- **Working Lunch: Final product (Cory/Dolores):** Update on web outline
- **Wrap up (Cory)**

Update for the Buffer Options for the Bay (BOB) project team

- **Friday 2/5:** Request for input from AC to Steve/Lisa
- **Monday 2/9:** Technical review panel plans due to Kalle
- **Friday 2/26:** Component leads submit updates for NSC progress report to Cory

CONTACT

Project lead:
Cory Riley
Cory.Riley@wildlife.nh.gov

Tech lead & fiscal agent:
David Patrick
david.patrick@TNC.ORG

Greetings everyone,

It's been a busy week for BOB, so in case you felt a bit overwhelmed, here's a round up of what's happening and related calls for action:

- Kudos to Steve and Lisa for organizing a great advisory committee (AC) meeting! Notes on google drive.
- The AC provided excellent input on selection of the subwatershed and David would like to schedule a webinar so we can weigh their input alongside what we've learned through the GIS and watershed wide community analyses.We don't expect everyone, but all are welcome. **Please take this doodle by 2/8** http://doodle.com/poll/t5ymqds4e22mnenh
- Some AC members were interested in digging into certain pieces of our project. If it would be useful to you, Steve and Lisa can facilitate the set up of smaller AC "working groups." This could mean additional calls or meetings, requests for feedback on progress, suggestions for resources—whatever makes sense for the kind of input you need. **Please let them know by 2/5 COB** if you're interested.

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leads have been asked to create a brief plan based on **this guidance by 2/9.** If you need help complying with this request, please contact Dolores ASAP.

- Thanks to those who responded to Steve's request for input on webinars for the advisory committee. He and Lisa will plan a webinar if a team member feels they will need more time to explain their work in advance of the fall AC meeting to make the meeting itself more productive. Let them know well in advance of your need for this so they can plan appropriately.

- Our first progress report to the NSC is due in March and component leads may be checking in with you to support that. NSC is looking to help us if they can, so if you have suggestions for what the funder could do to make your work easier, let your component lead (David, Steve, or Cory) know.

- Last, I will be on vacation between 2/10 and 2/19 (note the sunnier colors in our newsletter:). Please contact Lisa Graichen if you have general project questions.

Best,

Dolores

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Buffer Options *for the* Bay

ACTION PLAN

(Actions prioritized by our Advisory Committee highlighted in yellow.)

Actions
Website and associated products
Create a photo gallery on the website that shows before and after buffer restoration pictures, that demonstrate what a healthy vs. degraded buffer look like, etc.
Create a success story section of the website that highlights different types of buffer protection, regulation, management or restoration projects that have happened in NH. Include major players and funders.
Create a robust case study section to the website: include local case studies of approved ordinances, case studies of failed ordinances, case studies that include assessment of if development is deterred by strict setback ordinances, etc.
Create a graphic or way of showing the range of options for dealing with buffers- a spectrum from conservative to reformist with associated benefits and or a "rating".
Create a graphic that compares NH buffer regulation with other NE states.
Consider if additional distillation of any of the reports would be valuable for public or municipal audiences (two page summaries, etc.).
Create a one-page pdf that summarizes key economic findings from the project.
Mapping and spatial analysis
Create a map that has specific community by community information about what water bodies and buffers are protected and how that relates to impaired waters, etc.
Work with modelers to create and visualize different buffer options and how they influence ecosystem services at the parcel or site level.
Use aerial maps to assess historical trends in buffers, enforcement of current regulations, and map trends moving forward.
Show build out analysis of GB communities under current regulation vs. stricter buffer regulation to assess impact on land owners and tax base.
Coordinate the maps and resources created for BOB with maps and resources used by DES in permitting decisions.
Create interactive map products that show how different buffer widths and/or variable widths and vegetative cover would influence water quality, influence taxable property, etc.

Science and Synthesis
Enhance the non-regulatory options explored in the project and explore more creative tax incentives, buy back or trading programs, how buffers relate to other zoning requirements, etc.
Create a tracking and accounting method for buffers that is equivalent to other storm water BMPs. Consider how buffers can help towns meet water quality targets and if buffer "trading" is possible in the watershed.
Advance local cost benefit analysis of buffer protection. Include indirect values associated with buffers, and could include localized comparison of grey vs. green infrastructure and cost avoidance.
Consider policy options for cumulative impacts of development or harmful practices within buffer areas.
Update model ordinances that can be used by municipalities to enhance buffer management.
Create a way to assess buffer integrity and apply that integrity index to buffers in the watershed, map the results, and use them to prioritize restoration and enforcement.
Conduct additional science or convene experts to advance local science related to assessing the impact of buffer width and cover on benefits (water quality, flood storage, wildlife benefits, etc.) for different types of water bodies or stream orders.
Conduct additional social science to understand factors that influence municipal ordinance success or failure (may include looking at demographics, community leaders, etc.).
Study the loss of business, agriculture and developable land due to flooding vs. due to buffer regulations. Quantify economic loss if possible.
Targeted assessment of attitudes, and information or resource needs for individual land owners, developers and realtors.
Conduct additional analysis of enforcement gaps and develop or encourage potential solutions (joint enforcement code staff, aerial monitoring, options for conservation commissions, highlighting capacity gaps, etc.).
Conduct additional economic analysis that is linked to specific policy options (tax incentives, etc.).
Investigate rates of permit application denial or local variances: work with permitting groups to understand criteria and see if there are ways BOB results can inform those.
Explore the monitoring needed to assess buffer effectiveness, think about how this relates to CWA requirements for communities.
Conduct science or literature review to determine what water-based influences are impacting buffers in the region (boat use, docks, moorings, other recreational uses, etc.)
Consider how relevant the BOB work would be to non-riparian, non-tidal water bodies like lakes or isolated wetland complexes.
Incorporate drinking water into the policy assessment, community assessment, physical and economic science literature reviews and add sections to those reports.
Analyze past efforts to establish a stronger state wide buffer policy for how it was done, what factors influenced it's success or failure, etc.
Explore focusing policy efforts on some types of wetlands or riparian areas (cold water streams, drinking water supplies, vernal pools, etc.) based on functional value.
Include Maine in aspects of this study (Community Assessment, Policy Analysis, etc.)

Outreach and Engagement	
Create new or use existing teams that can directly assist communities in using the information that came out of BOB (and other relevant info) to adopt or improve local ordinances, enhance enforcement, apply for appropriate funding sources, and evaluate projects.	
Integrate BOB results into ongoing efforts in the Watershed (Board Empowerment Series, Great Bay 2020, Great Bay Resource Protection Partnership, NROC outreach, etc.)	
Conduct buffer workshops specifically for code enforcement officers and municipal board members.	
Develop a comprehensive buffers outreach plan: determine audiences, key messages for each audience and how they will be reached.	
Update PREPA information about buffers and link to this project.	
Enhance public outreach efforts that highlight what a buffer is and why they are important.	
Create resources explicitly for developers, realtors or landowners who are working in difficult corridors with extensive buffer areas.	
Conduct outreach and technical assistance specifically around conservation and restoration priorities related to buffers.	
Build awareness of economic benefits of open space, stewardship, restoration etc. with buffers as a piece of that outreach.	
Link buffer project to drinking water efforts; outreach, mapping, messaging.	
Conduct buffer workshops specifically for code enforcement officers and municipal board members.	
Incorporate the concept of buffers into K-12 education opportunities or curriculum.	
Work with funding agencies and foundations to encourage bonus points and other incentives to prioritize buffer related projects.	
Work with UNH Cooperative Extension on working with ecological landscaping for landscape professionals.	
Conduct outreach to key state-level decision makers to raise the profile of this issue and catalyze action towards increased protection for buffer. This may include the creation of a legislative working group.	
Conduct a study to determine the cost of protecting an acre of buffers vs. restoring an acre of buffer.	

BOB Technical Review

1. Project Component: Community Assessment

2. BOB Overall Goal: *The goal of the Buffer Options for the Bay (BOB) project is to enhance stakeholder capacity to make informed decisions related to the protection and restoration of buffers around New Hampshire's Great Bay. To this end, this project will conduct an integrated assessment that combines, interprets, and communicates science-based information focused on the following policy question: What are the regulatory and non-regulatory options for addressing the challenges to effectively protecting and restoring buffer zones around New Hampshire's Great Bay?*

3. Key Features:
Overview: The Community Assessment will help us better understand the barriers, opportunities, values, perspectives, language, and social/political context related to buffer management in the Great Bay watershed. We aim to get an in-depth understanding of the context for buffer-related decisions at the local level – e.g., how these decisions happen, what factors influence these decisions, how decision-makers feel about different buffer-related options, what contextual factors might influence which options work in one community but not another, etc.

Components: The Community Assessment includes components at both the watershed-wide level and at the subwatershed level (i.e., focused in on one subwatershed within the Great Bay watershed, such as the Lamprey or the Winnicut River subwatersheds). The intention of this tiered approach is to collect information that pertains to the whole Great Bay watershed, but also dig in at the local level to gain a deeper understanding of how buffer-related decisions are made by communities and what the associated challenges and opportunities are. Also, findings from the communities involved with the subwatershed-level work may be tested in additional communities outside of that subwatershed to see how common they are.

The selection of the focal subwatershed is based on a set of criteria suggested by the Project Team (PT) and then vetted with the Advisory Committee (AC). Within the selected subwatershed, three or four communities will be identified to work with at the more in-depth level. We will reach out to several members of those communities and any subwatershed groups (e.g., Lamprey River Watershed Association) to invite them to join the Advisory Committee for the remainder of the project.

Watershed level:

- Develop an inventory of municipal regulations related to buffers
- Create a database of municipal contacts
- Review relevant watershed-level resources (e.g., 2015 PREPA reports)
- Conduct informal interviews with colleagues about their experience with communities and perceptions of barriers to effective buffer management

Subwatershed level:

- Review existing resources (e.g., master plans and newspapers) and identify existing community groups (e.g., a local watershed group)
- Observe relevant community meetings (e.g., conservation commission and planning board meetings) and review meeting minutes
- Conduct focus groups, interviews, and surveys with municipal decision-makers and stakeholders

- We anticipate holding two focus groups in each community, with individual interviews used both to inform the focus group design and to follow up after focus groups if there are lingering questions. We may use surveys as a supplemental method as well (for example, to get information about stakeholders' preferred language related to buffers).

- Employ stakeholder mapping methods (e.g., Susan Clark's *Policy Process*) to help map the values, perspectives, and preferences of different stakeholders

For the interviews, focus groups, and surveys, we anticipate engaging municipal officials and board members (e.g., selectmen, planning board members, conservation commission members, etc.), as well as individuals involved with local watershed or conservation organizations, developers, consultants, and other stakeholders as needed. We will use stakeholder mapping to identify the community members involved with and/or affected by buffer-related decisions and to guide our investigation into their attitudes, perspectives, and values. The interviews, focus groups, and surveys will be focused on identifying and understanding barriers, opportunities, and preferences related to different buffer management options. We also anticipate incorporating some questions related to the language used to refer to buffers (e.g., what terms resonate better with different stakeholders). The array of options included in the Community Assessment methods will be informed by the policy analysis component in order to gain information about both the options commonly used in New Hampshire as well as options from other states that could be applicable to New Hampshire.

Products: The Community Assessment component will yield a summary report and will inform the project's process of evaluating options, integrated assessment report, and final products.

Timeline:

1) Develop Community Assessment plan and get PT and AC feedback. (Sept. 2015 – Jan. 2016)
2) Once subwatershed and communities have been chosen, refine the assessment plan as needed and compile resources specific to those towns. (Feb. – March 2016)
3) Implement the Community Assessment plan in each community, documenting findings and lessons learned along the way. Share progress with team as needed. (March – May 2016)
4) Analyze results, draft Community Assessment report, and share with PT and AC. Incorporate findings with development of final products. (May – Sept. 2016)
5) Follow up with communities to share results of project. (Sept. 2017?)

4. Choices/decisions

1) *One subwatershed:* The idea of focusing in on one or two subwatersheds was laid out in the proposal, with the primary intention of laying a strong foundation through this project for future work that can have a positive impact at the subwatershed level. The Project Team is interested to know if a subwatershed-scale approach is effective. The engagement team decided to focus in on one subwatershed, rather than two, because that seemed to better suit our capacity. We also felt there may be value in working with three or four communities within one subwatershed rather than just one or two in multiple subwatersheds. For example, this enables us to get a broader coverage of the communities within a subwatershed, making the subwatershed-level approach more valuable. It also permits us to start testing whether we are finding some similar results among communities within the subwatershed.

2) *Subwatershed and community selection:* Based on our evaluation of subwatersheds so far, our top choices are 1) the Lamprey River subwatershed and 2) the Exeter-Squamscott subwatershed. The criteria we have incorporated are based on input from the Project Team and include the following:
   a. The subwatershed should include communities showing differing levels of progress in terms of buffer-related regulations (this is based on the 2015 PREPA report cards for shoreland protection and freshwater wetlands). The Project Team is interested in learning about the barriers faced by the communities performing less well (according to PREPA) as well as the successful experiences of the higher performing communities.
   b. The subwatershed should include a mix of MS4 (Municipal Separate Storm Sewer System) and non-MS4 communities (or communities with a waiver). The Project Team is interested in learning about whether there are differences in the perspectives, challenges, and opportunities related to buffers between communities that are regulated under this program and those that are not.
   c. The subwatershed should include a geographic mix (i.e., both communities close to Great Bay and communities further inland). The Project Team is interested in learning whether there are differences in the perspectives, values, and opportunities between the more inland communities and those closer to the bay.

   We are also collecting information about other buffer-related activities going on (e.g., PREP-funded projects) as well as other projects and data available (e.g., the WISE project in the Exeter-Squamscott subwatershed). In addition, the GIS work being conducted by the project's technical team will help identify both areas of need and areas of opportunity to help us make sure we are focusing our efforts most effectively.

   To select communities to invite to participate in the Community Assessment work, we will need to balance our criteria with the interest, willingness, and availability of the community members we need to engage. The Advisory Committee provided input at the first meeting on January 21, 2016. They offered a variety of suggestions that will help us choose several communities to focus on for the Community Assessment work, including:
   - Population density
   - Development potential
   - Location of impaired waters
   - Whether the river serves as a drinking supply
   - Presence of an active riverine group or watershed association
   - Communities that may soon be required to comply with an MS4 permit
   - Communities that have not received a lot of attention (in terms of other projects or resources), or perhaps one that has and one that has not

   Now that we have gotten feedback from the Advisory Committee, we will incorporate as much as we can and go back to the Project Team to finalize the selection.

3) *Methods:* We decided to use focus groups as a primary method both to be able to get perspectives and information from multiple people at once, and to be able observe discussion amongst key decision-makers and gather information about those dynamics and relationships. We anticipate using individual interviews in advance of the focus groups to inform their design, as well as following the focus groups to address any lingering questions or dig deeper as needed. We may use surveys as a supplemental data gathering technique as well to provide an additional opportunity for

participants to contribute and to incorporate questions that might be particularly conducive to that method. We will work with the policy analysis team and with the project's communications lead to incorporate relevant questions and topics grounded in the progress they have made so far.

MAPPING PRODUCTS SUMMARY

Table of Contents

A. Integrating mapping products to advance buffer management

A key goal of this project was to help prioritize how and where to focus buffer protection, restoration, and management in the Great Bay Region. To this end, the BOB team created four sets of maps to help landowners, communities, resource managers, and policy makers do the following:

- Locate important buffer areas;
- Prioritize buffers for conservation or restoration based on their capacity to provide specific benefits;
- Focus resources and collaborative efforts to improve buffer management; and
- Apply to funding opportunities, including New Hampshire's Aquatic Resource Mitigation Fund.

A. Creating user driven maps

Based on extensive feedback from the advisory committee and project team, the GIS lead created hundreds of standalone maps, as well as a user guide for people who wanted to access an online GIS platform to combine the buffer information with other geospatial layers. It was clear that communities and technical assistance professionals on the Advisory Committee wanted pdfs that were easy to download and print. They voiced a preference for town specific maps, because that is where land use decisions are made in N.H., but there was also an acknowledgement that having the context of the surrounding towns would be important for watershed associations and groups that worked across jurisdictions in the Great Bay region. Therefore, town specific information was clipped to town boundaries, but the maps for surrounding areas can be seen in greyscale. For each of the 42 New Hampshire municipalities in the Great Bay watershed, four maps are displayed:

- Maps of buffers that provide water quality benefits;
- Maps that provide wildlife benefits;
- Maps that provide flood protection; and
- Co-occurrance maps that display areas that do all three of the above.

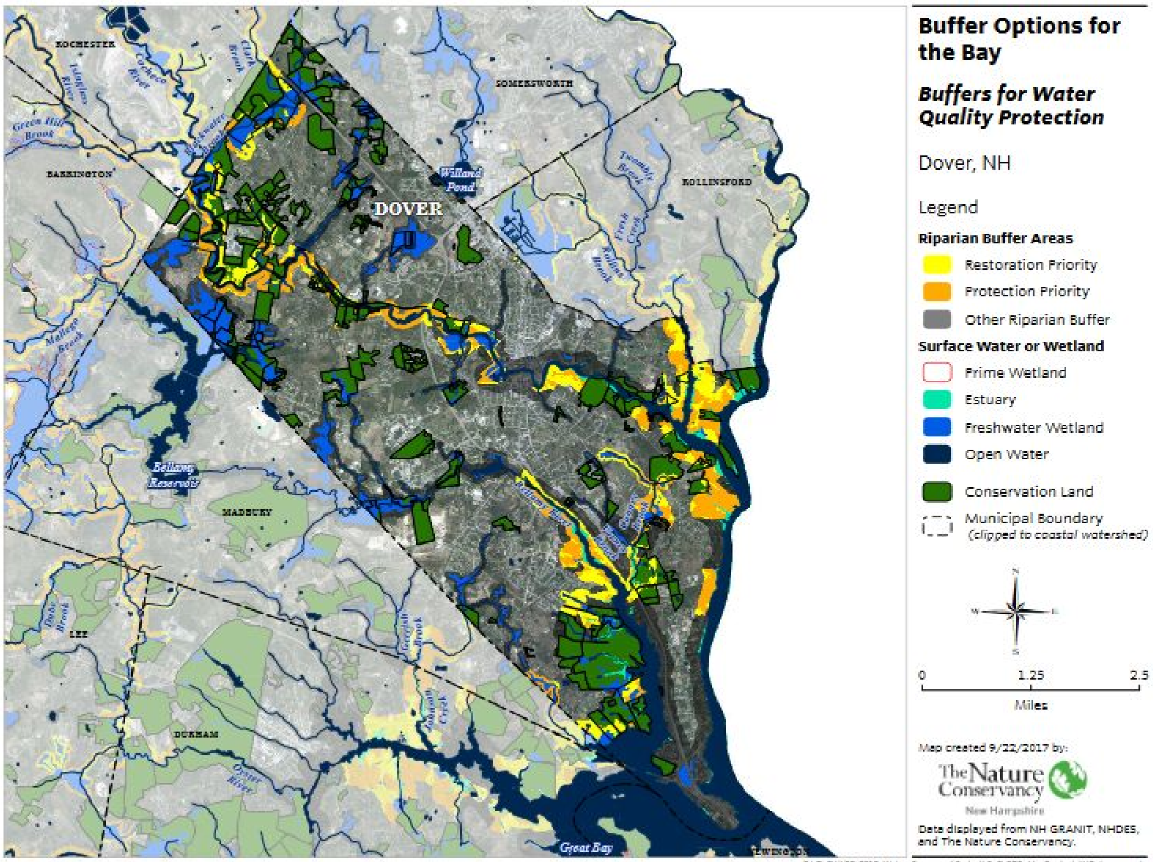
The maps presented on the BOB website were originally created for other purposes. The three previous geospatial analysis that were used to create the BOB maps are: the Sea Level Affecting Marsh Migration Model (SLAMM) done by NHFG in 2016, the 2015 Wildlife Action Plan (WAP) Habitat Maps, and the *Land Conservation Priorities for the Protection of Coastal Water Resources*, an assessment done in 2016 to identify land conservation opportunities that provide the greatest benefits to coastal water resources. The *Land Conservation Priorities for the Protection of Coastal Water Resources* study included a flood risk and mitigation layer, a layer identifying important public water supply areas, and a pollutant attenuation and removal layer. The analysis included information on buffers, and used an approach to determine buffer widths based on stream order and tidal status. First and second order streams and their associated wetlands were mapped with a 50-meter (164 foot) buffer, third order and higher streams and their associated wetlands were mapped with a 100-meter buffer (320 feet), and tidal shorelines and wetlands were mapped with a 2-meter (6.6 foot) vertical buffer and 200 meter (656 foot) horizontal buffer beyond the extent of the vertical buffer (i.e. first a 2-meter rise in sea level was simulated, then a 200-meter buffer was mapped from the "raised" sea level boundary). This same approach to buffers was used to clip data from the SLAMM and WAP maps for the BOB maps.

Maps for water quality protection: These maps help to identify riparian buffer protection and/or restoration priorities to maintain and improve water quality in our rivers, lakes, ponds and estuaries. This set of maps can be used to support the following activities:

1. Identify land protection and restoration projects targeted specifically to improve water quality
2. Create riparian buffer restoration plans
3. Write buffer ordinance language
4. Set up monitoring and/or code enforcement protocols

These maps were originally created for the *Land Conservation Priorities for the Protection of Coastal Water Resources* pollutant attenuation and removal layer. The layer includes riparian buffers that intercept stormwater runoff and at the same time maintain natural cover adjacent to surface waters, and riparian wetlands that are efficient at treating pollutants already in surface waters.

Example of a water quality protection map:



Maps displaying flood storage and risk mitigation areas

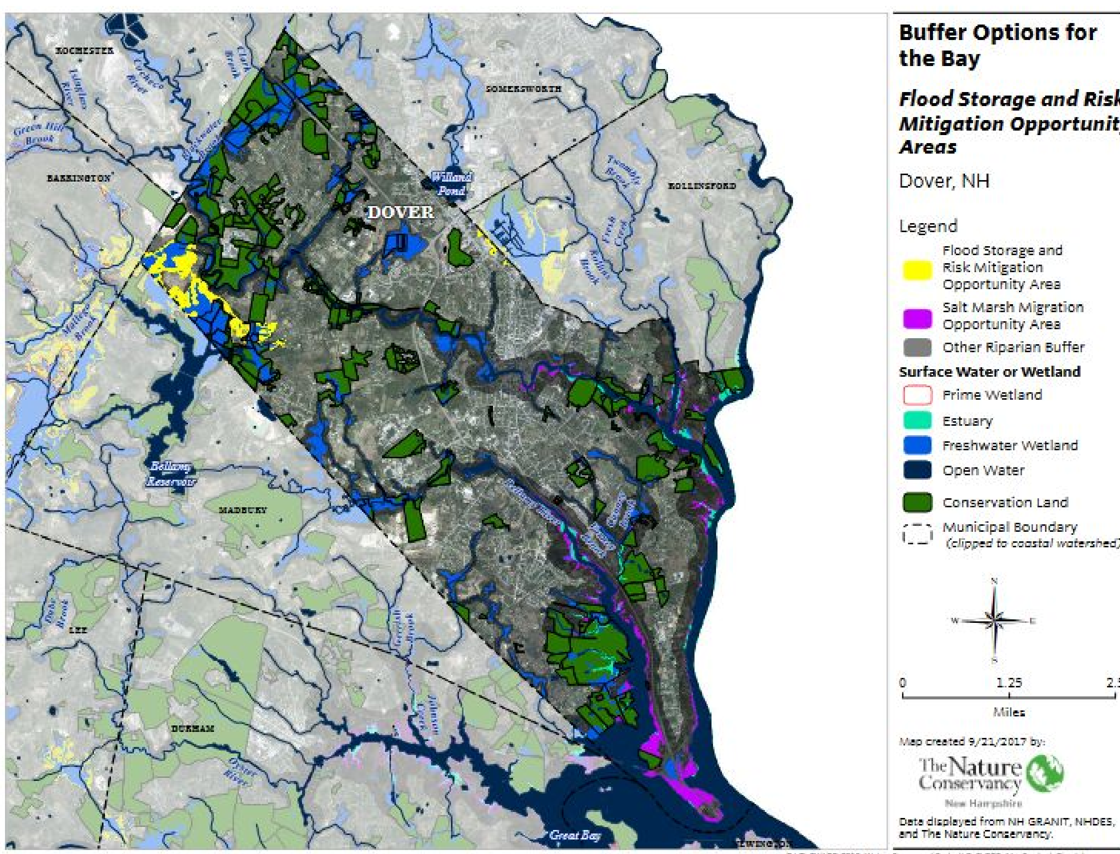
These maps focus on three climate resilience actions: flood storage, risk mitigation, and salt marsh migration. Natural areas that attenuate flood waters (both from extreme precipitation events and rising sea levels) provide dual benefits: they reduce flooding and they keep people and infrastructure out of harm's way. The areas identified on these maps show where green infrastructure should persist to maximize ecosystem services and reduce people's exposure to flood risks. These maps can be used to support the following activities:

1. Identify high risk areas for building (due to flood risk)
2. Proactively protect high capacity flood storage lands
3. Develop a climate resilience plan
4. Inform an emergency management process

5. Create salt marsh restoration plans and strategically protecting low-lying coastal lands to allow for inland salt marsh migration.

The data in these maps includes results from two previously funded spatial studies in NH. New Hampshire Fish and Game ran a Sea Level Affecting Marsh Migration Model in 2016 based on LIDAR data, local habitat, accretion, fetch, water level and locally agreed upon SLR scenarios. In 2017, TNC completed an analysis to look at where conservation lands could protect water resources. This included flood risk and mitigation areas. The flood risk areas use FEMA mapping layers, and the mitigation layer looked at elevation, soils, slope and wetland type to determine the flood storage capacity of areas in the seacoast region. This analysis was limited to the geographic availability of LiDAR data which is available for 34 out of 42 communities. Those communities missing include: Brookfield, Danville, Farmington, Kingston, Middleton, New Durham, Northwood and Strafford.

Example of a flood risk and mitigation map:



Maps identifying important wildlife areas in buffers

These maps identify high quality wildlife habitats within riparian buffers based on New Hampshire's Wildlife Action Plan (WAP). This plan classifies habitats in two tiers: Tier 1 areas are the highest ranked habitats across the state. Tier 2 areas are the highest ranked habitats at a more local scale.

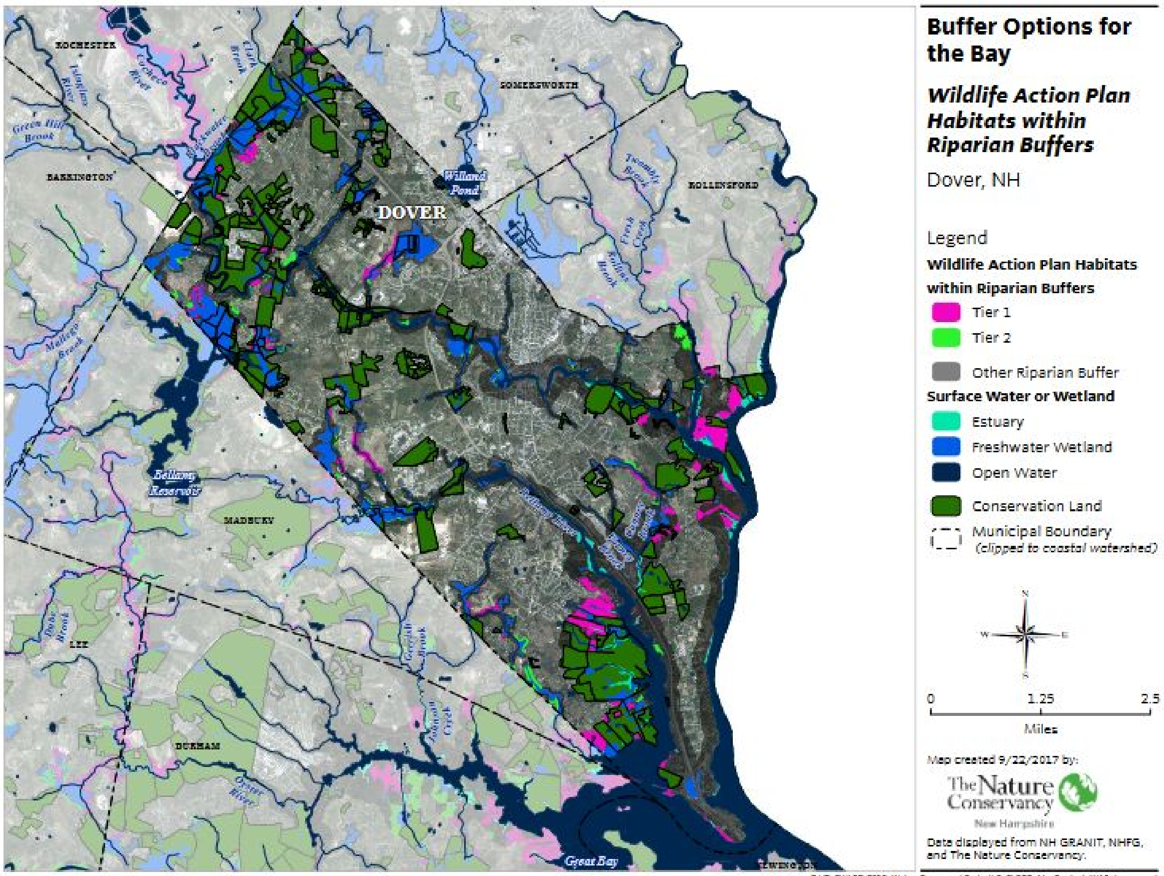
These maps can be used for the following activities:

1. Identify riparian corridor protection priorities (many wildlife species depend on riparian corridors for travel, dispersal, and essential habitat)
2. Write a wildlife management plan
3. Write buffer and wetland ordinance language
4. Develop a public lands management plan

These maps are derived from the 2015 mapping analysis done for the NH Wildlife Action Plan. These maps show where the wildlife habitat is in the best relative condition in New Hampshire, particularly for Species of Greatest Conservation Need. The analysis used data on species locations, landscape setting and human influences that affect the ability of habitats to be used by wildlife. This resulted in three tiers of rankings, Highest Ranked in the State (Tier I), Highest Ranked in the Biological Region (Tier II), and Supporting Landscapes (Tier III). Tier I and II layers were used to indicate where important buffers for wildlife are in the BOB project.

Highest Ranked in the State (Tier I) habitats include the top 15% by area of each habitat type in the state. Especially rare habitats include 100% of the area to emphasize their importance, and critical habitats of state-listed species are also a part of the Tier I area. Highest Ranked in the Biological Region (Tier II) compares the habitats within regions of the state that have similar climate, geology and other factors that influence biology. Within each biological region the top 30% of each habitat is included. Some high priority natural communities as ranked by NH Natural Heritage Bureau were added to highlight the importance of plant diversity in habitat quality. This layer allows users to understand how important a habitat area is to that part of the state.

Example of a wildlife habitat map

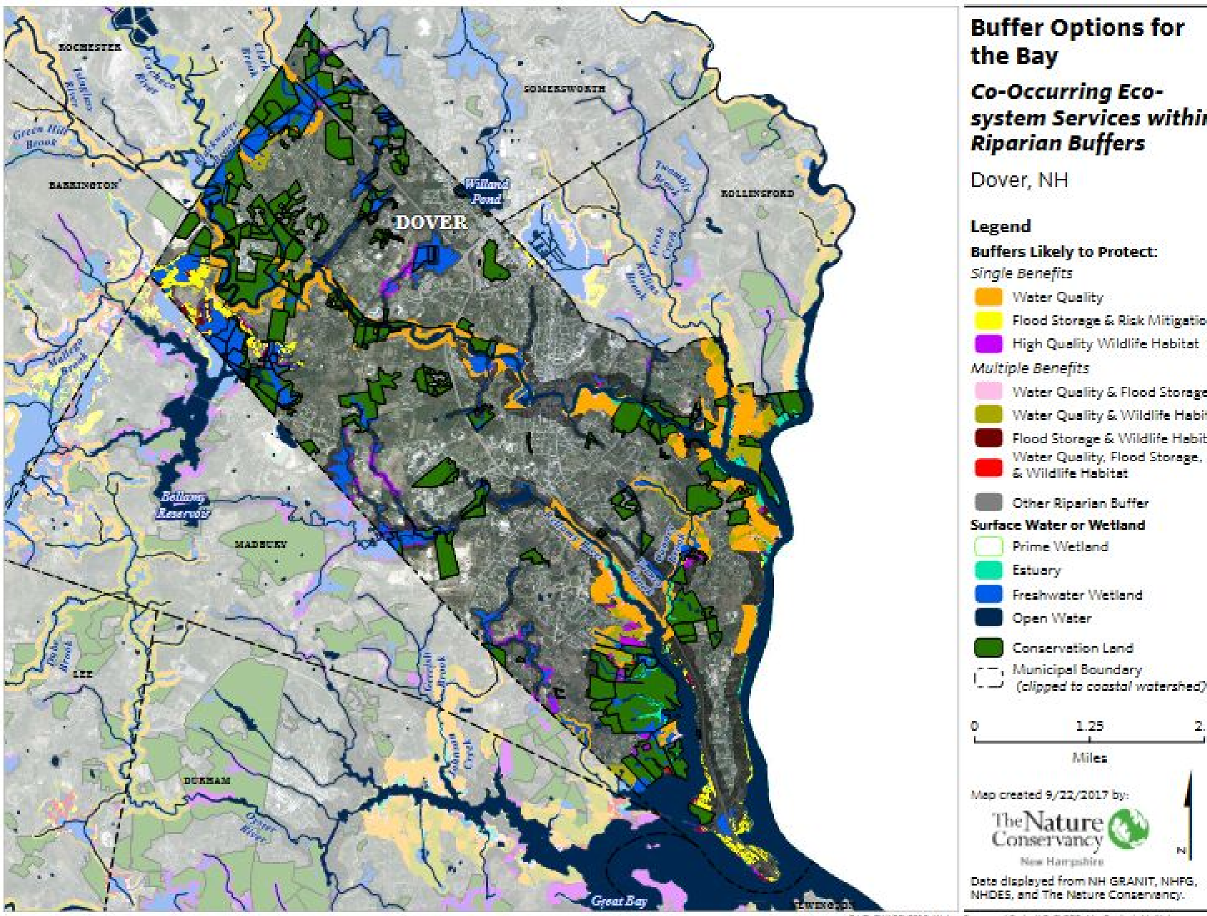


Maps displaying co-occurring benefits in the riparian area

These co-occurrance maps highlight buffer areas that can provide up to three benefits, i.e., water quality protection, flood storage and risk mitigation, and wildlife habitats as designated in the Wildlife Action Plan. These maps can be used to support the following activities:

1. Develop and prioritize buffer management and restoration plans
2. Identify the most efficient use of resources and effort
3. Site construction and development proposals

Example of a co-occurrence map



A complete set of the maps is downloadable from the BOB website [“Maps” page.]

C. Creating a user guide for accessing data layers

The NH Coastal Viewer is an online mapping tool with a geographic focus on New Hampshire’s coastal watershed communities. As a deliverable of this project, the team wanted to make sure that the mapping products were available on this platform, which is supported by the state of New Hampshire. The town by town maps were an additional suite of products that were a direct result of the feedback the team received throughout the project and provide a more direct way of accessing community specific information. All of the mapping product data layers used to create the town by town maps are accessible for viewing using the NH Coastal Viewer at: http://nhcoastalviewer.unh.edu/. A user guide was created and posted to the BOB website on the maps page with instructions for how to find the relevant layers within the Coastal Viewer.

Buffer Options for the Bay: Exploring the Trends, Science, & Options for Buffer Management in the Great Bay Watershed

Key Findings from a community assessment

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I. Executive Summary

In New Hampshire, land use decisions involving buffer lands surrounding water bodies are often made by communities and individual landowners. These decisions are influenced by many factors, including local regulations and governance structures, prevailing culture, the community's economic and natural resources, and the often diverse perspectives of its citizens. Efforts at any scale to protect, restore, or manage buffers in support of water quality protection or other ecosystem services must keep these local considerations in mind if they are to succeed. To address this need, this report presents an analysis of the local factors influencing buffer-related decision-making within four communities in the Exeter-Squamscott subwatershed and the relevance of these factors to communities throughout the wider Great Bay watershed. This study's overarching goal is to help outreach, communication, and technical assistance efforts related to buffers become more targeted, relevant, and helpful for Great Bay communities and the practitioners who work with them on this issue.

This analysis was commissioned by Buffer Options for the Bay (BOB) project, a grant-sponsored collaboration of public, academic, and nonprofit organizations dedicated to enhancing the capacity of New Hampshire stakeholders to make informed decisions that make best use of buffer lands to protect water quality, guard against storm surge and sea level rise, and sustain fish and wildlife in the Great Bay region. The project defines buffers as naturally vegetated segments of land directly upslope of a water resource, such as a lake, stream, river, pond, estuary, or other wetland type.

Using a combination of interviews with community stakeholders and document review for the four focal communities, the study examined the values, perspectives, and concerns that influence decisions about buffers; the challenges and opportunities associated with different buffer management options; and the information gaps and support needs experienced by local decision makers. A total of 38 individuals were interviewed in 28 interviews: 13 municipal staff (code enforcement officers, planners, town administrators or managers, other), ten municipal board members (conservation commission, planning board, select board, and zoning board members), and 15 other stakeholders (engineers, wetland scientists, developers, regional planners, and other outreach and technical assistance providers). This analysis reports on the perceptions heard from the interviewees. Findings from this analysis were then tested via survey for their relevance to communities throughout the Great Bay watershed. Seventy-three people from at least 28 communities responded to the survey, generally showing an overwhelming degree of agreement with the CA findings.

Chief findings from the CA analysis include the following:

- While responses to questions about community values varied, the analysis did identify some common types of values that provide important context for efforts to conserve, restore, or manage buffers. Values mentioned included the following:
  —*Protection* of property rights and privacy, hydrological benefits of buffers (e.g., flood storage), and public health;
  —*Preservation* of community character, which is defined by factors including a sense of history,

public areas for children and families to recreate, a town center, walkability, open space, town pride and reputation, and engaged citizens and school system;
—*Importance of water, particularly local water bodies,* which is manifested by access to water, views, and clean water for drinking water and recreation;
—*Habitat*: Natural resources, wildlife and forests, especially as in relation to community character;
—*Financial vitality* conferred by adjacent water bodies, which make communities desirable places to live and do business, enhance property values, and help sustain the tax base, and also contribute to avoided costs (e.g., by protecting water quality, avoiding flood damage and pollution events that impact property values, enhancing tourism and public health).

- Buffer-related decisions are inherently complex at the local level, requiring decision-makers to balance many factors, including community character, natural resource protection, environmental concern, economic development and growth, respect for property rights, abutter concerns, and support for local agriculture and forestry.

- While buffers have public benefits, their regulation does not affect all community members equally. Buffer management is seen as more burdensome for homeowners than developers and associated challenges are especially pronounced with waterfront properties. Another equity concern is that lower watershed communities benefit from the water quality impacts of buffer regulations in upper watershed communities.

- Property rights and privacy concerns are major impediments to buffer protection. Many view their land as an investment for their children and some fear that regulations related to buffers will prevent them from subdividing their property and maximizing its value for heirs. Consistent with the state's "live free or die" culture, some observed that they should be able to do what they want with their land or expressed frustration regarding conservation of buffers, wetlands, and other resources, i.e, "when is enough, enough?"

- There are unique challenges related to changing community composition. For example, longer term residents may have a stronger connection to the community character and what the community was like in the past (i.e., with less development, more natural resources), and a better awareness of the rationale behind the municipality's ordinance. New residents (especially those coming to New Hampshire from more urban areas) lack that awareness of development trends and what has been "lost" in terms of natural resources and community character. In addition, younger residents and older residents may have different visions and priorities for what they would like their community to be like.

- Buffer decisions are often perceived as a choice between natural resource protection and economic development and, in general, there's a lack of understanding about the potential economic benefits of protecting open space and natural resources. Conservation land (especially with public access) may be an economic draw, but it also means there's less available land for growth. Buffer regulations were perceived by some as "anti-growth" and adding to the costs of development. Some feared more restrictive buffer regulations would drive developers away.

The findings listed above reflect what was heard in the 28 interviews. To understand if these perceptions hold true for other parts of the Great Bay Watershed, a survey was administered to municipal representatives in all 42 communities surrounding the bay. The survey asked respondents to indicate their level of agreement with the interview results. The **top four findings** with the greatest degree of agreement (>86%) from the 73 survey respondents were as follows:

- Buffer-related decisions are inherently complex, requiring municipalities to balance many factors including property rights, community character, natural resource protection, abutters' concerns and economic growth.
- People may not understand the individual and social benefits of buffers.
- Buffer oversight and enforcement can be logistically difficult and lack capacity.
- Developers want consistent regulations, flexibility in the review process, and not a 'one-size-fits-all' rule.

The results of this analysis are intended to be a resource for the organizations involved in the BOB project and others engaged in helping communities and individuals to better understand local-scale perspectives, experiences, approaches, needs, and opportunities. The analysis process also provided an opportunity to build relationships with local stakeholders through engagement in interviews. The purpose of this effort is to ensure that the BOB project's evaluation of options and product development processes are grounded in the realities communities are facing and informed by the perspectives of key stakeholders.

The team also has conducted several reviews of the biophysical literature that underpins buffer management, an economic analysis of the values placed on the water quality benefits provided by buffers, a buffer-focused GIS analysis of the Great Bay region and a policy analysis. The results of these analyses are captured in individual reports, available at www.bufferoptionsnh.org/reports. They also have been integrated into a web site (www.bufferoptionsnh.org) intended to inform discussions around buffer management in the region, open the door to new and needed research; and encourage strategic investment. Finally, the team created a collective action plan (www.bufferoptionsnh.org/action-plan) to encourage collaboration among outreach professionals as they work with stakeholders on advancing effective buffer policy and practice at the community and state levels.

II. Community Assessment Interview Findings

A. COMMUNITY VALUES

Thirty eight stakeholders were interviewed to gain an in-depth understanding of the buffer-related decision-making process at the local level. Each interview included questions related to perspectives, preferences, challenges, and opportunities related to regulatory and nonregulatory approaches to buffer implementation and management. Individual land owners were not interviewed as a part of this project; the focus was on municipal decision makers and developers who work with towns and cities. (For more on community and interviewee selection; the methods underpinning the interviews, watershed survey, and analysis; and resources that contributed to this work, please see this report's appendices, starting on page 23.) This document reflects the team's analysis of the interviews and survey data and is organized in a way that summarizes responses regarding challenges and barriers, reflections on buffer policy and regulations, articulated needs that were expressed during the interviews, and ideas about how to communicate about buffers. Throughout this analysis, it was clear that people understand the issue of buffers in the context of broader societal and personal values. When asked directly, responses varied between communities and between interviewees (even within the same community), but generally people referenced the following values:

- *Protection*
  - Property rights and privacy
  - Hydrological benefits of buffers, such as flood storage
  - Public health

- *Community character and culture*
  - Community character and history, especially rural/agricultural character
  - Public areas for children to play/families to recreate
  - Town center, walkability, open space, "quality of life"
  - Town pride, community reputation
  - Engaged citizens
  - School system

- *Water-related*
  - Water views and access
  - Clean water for drinking water and recreation
  - Generally stronger connection to local river (or other water body) than to Great Bay

- *Habitat*
  - Natural resources and endangered species
  - Natural resources in the community, e.g., forests that contribute to community character.

- *Financial connection*
  - Desirable place to live and do business, e.g., near the bay, a river, fun town, etc.
  - Property values, e.g., property as an investment for one's children
  - Affordable housing, low taxes, economic growth, sustainability of the tax base
  - Cost avoidance. e.g., related to water treatment, flood impacts, pollution impacts on property values and tourism, etc.

Some of these values are easier to connect to buffers than others. Here are a few ways to learn more about a community's values when embarking on buffer-related work:

- Review the municipality's master plan and zoning ordinance for descriptions of values.
- Gather information about relevant past votes, e.g., funding for land conservation.
- Conduct informal or semi-structured interviews with community stakeholders; try to get a variety of perspectives, five at the very least. Ask interviewees to describe the key values of the community that come to mind, as well as what they personally value most about living in the community. A survey may also work, but results will be less rich.
- Consider hosting a community dialogue or focus groups to get more in-depth information.

Use the values you identify to inform the way you communicate in the community. For example, make connections between buffers and protecting their values; gather additional information to capture the benefits and downsides of buffers related to those values; and identify several options for the community that connect to and help protect these values. Some education work may be needed to make the connection between certain buffer functions and the community's values clear.

B. OVERARCHING THEMES

The different values that people bring to a conversation about buffers likely influence some of the overarching themes found in this assessment. These themes are key, contextual take-home lessons that don't necessarily fit into the subsequent findings categories, but the team felt were important to capture and convey due to their prevalence in the interviews.

- **It's challenging to balance the different factors in decision making:** Buffer-related decisions are complex and often call upon decision-makers to balance a number of factors.

- Community character
- Natural resource protection
- Environmental concerns
- Economic development and growth
- Purpose of a municipality's ordinance
- What's best for the town
- Respecting property' rights
- Abutters' concerns
- Supporting agriculture/forestry

- **Inequity of burden:** While buffers have public benefits, they do not affect all landowners equally.
  - Navigating buffer regulations is more burdensome for homeowners than developers and may be more challenging for residential than commercial developers.
  - This is especially an issue with waterfront property, which may include higher value land, but also is subject to greater restrictions. Often, owners purchase the property to be able to see the water.
  - Provisions to "grandfather" longer-term landowners into new regulations can be perceived, in a way, as forgiving past buffer impacts.
  - Landowners who developed by previous rules may not understand new regulations.

- **A strong sense of property rights:** Property rights and privacy concerns are a major impediment to buffer protection.
  - Many fear that regulations will prevent subdividing the property for their children. They see their land as an investment for their children.
  - The "live free or die" mentality plays a role in New Hampshire, i.e., "It's my land, I can do what I want."
  - "When is enough, enough?" is a common perspective, especially as it relates to regulation, conservation land, buffers, wetlands, etc.

- **Competition:** Natural resource protection is perceived as competing with economic development and growth.
  - The good, "easy" land has been developed and the "challenged [for development] land" is remaining, resulting in more pressure to reduce the size of buffers.
  - Wetlands and buffers contribute to higher site work and approval process costs, which can kill projects and make development more expensive.
  - Some feel a need for more development to pay for infrastructure, grow the tax base, and achieve their vision for the community. Conservation is an economic draw, but it also means there's less available land to develop. There appears to be a lack of awareness and understanding about the economics of open space.
  - If other communities have less restrictive buffers, will developers go there instead? Some fear that more restrictive buffers will drive developers away, while others were not

as worried about driving away development, wanting to maintain the community character. If developers move up into the watershed, though, that still affects downstream communities, i.e, through water quality and economic impacts, so individual communities' decisions affect their neighbors.

- Some feel that buffers ruin economic development potential and property values and natural resource protection stifles economic growth. The sense is that the two are mutually exclusive.
- Some see buffers as anti-growth. For example, buffers and other regulations lower density and contribute to less affordable housing and attract fewer young people.
- Some think rural communities don't have enough development pressure to need buffers, however, some upper watershed communities may have a stronger connection to their community character and more resistance to growth, and may view buffers more favorably.

C. CHALLENGES & BARRIERS

Interviewees were asked about challenges related to implementing or working with buffers. This section groups their responses into themes. Reflecting on these challenges can help partners interested in advancing buffers to target their efforts.

- **Municipal decision-making process**
  - Municipal decision-making process is parcel-by-parcel; it's hard to take a town-wide view.
  - Each application should be evaluated on its own merit, but municipal boards fear setting a precedent and getting sued. This fear can influence decision-making.
  - The town meeting process slows down decision-making and regulatory change.
  - SB2 (a form of town meeting that has a deliberative session and a voting session) leads to people voting without knowing what they're voting for.
  - Municipalities are dealing with bigger issues than buffers.

- **MS4 (Municipal Separate Storm Sewer System) permit:** Impending MS4 permit has been an excuse to wait on strengthening the buffers—some think the permit might make the municipality further expand buffers.

- **Municipal boards:**
  - Conservation commissions lack power and a formal role in the decision-making process.
  - Zoning board challenges include timing, (i.e., by the time they get a case, it's either going to happen or has already happened; they're dealing with people caught violating the regulation, rather than proactively coming before the board) and subjective criteria.
  - There's often a shortage of board members, especially young people and people with technical expertise and legal knowledge. It seems especially hard to fill the zoning board.
  - Turnover affects the personality of the board, contributes to inconsistency, and results in a loss of institutional knowledge. Boards probably need ongoing outreach due to turnover.

- Boards often lack technical expertise and aren't comfortable with technical language.
- Boards have to deal with developers and consultants that threaten the takings clause and bring in lawyers, show up to board meetings with new information, or bully the boards.
- Developers are from outside the community, so municipalities need to defend their values.
- Boards get incomplete, poorly filled out applications, but are under pressure to decide.
- It can be difficult for board members (volunteers) to attend trainings.
- Some boards are worried about developing a reputation for being anti-development.
- There are questions and different perspectives about whether boards should compromise or stick strictly to the ordinance.
- Board members are often older and may have a different vision for the municipality than younger residents.

- **Municipal ordinance**
  - Piecemeal revisions of the ordinance are problematic. Municipalities are dealing with the zoning boundaries that were determined decades ago, which may not fit today's needs.
  - It's not just the ordinance, but also how it's enforced and decision makers' visions for the municipality.

- **Enforcement**
  - Municipalities and the state lack capacity for oversight and enforcement.
  - Enforcement can be logistically difficult, e.g., how to effectively monitor and implement a no-clearing buffer or fertilizer restriction? What's the punishment for buffer violations? Timing of enforcement opportunities isn't ideal, e.g., violations can occur after inspection.
  - Code enforcement officers may lack a clear connection to the rationale for buffers, and often have other priorities for code enforcement above buffers.
  - If a municipality feels like it doesn't have the capacity to enforce a buffer ordinance, staff and board members may be reluctant to consider the ordinance in the first place.
  - Code enforcement officers sometimes hear people say, "Why didn't someone tell me I couldn't do this?" People often don't take responsibility to find out regulations proactively.

- **Lack of understanding, awareness, and connection:**
  - There is a broad lack of understanding and awareness of 1) the functions and values of wetlands and importance of buffers; 2) drinking water sources, quality, and threats; 3) rationale for regulation, especially buffers; and 4) purpose of municipal boards and existence of municipal regulations.
  - People tune out the importance of buffers (and other environmental protections and municipal regulations), or think it doesn't apply to them. Most (especially newcomers) aren't aware of the ordinance, let alone buffers. It can be difficult to understand the benefits of some municipal regulations. Do residents who violate buffers or other regulations not know or not care? Benefits from environmental resources are externalized, and there is a disconnect from cumulative impacts.
  - There's a broad disconnect from the environment. It can be difficult to maintain and grow a

sense of connection to the municipality's history and values, especially with newcomers and changing demographics. Shifting baselines are also a challenge, for example, a disconnect from the municipality's agricultural past, different perceptions of "rural," different baselines for water quality, etc.

  - It is tough to engage community members, especially younger residents. The "bedroom community" nature and changing demographics contribute to lack of participation, loss of connection to the past, unfamiliarity with the process, and sometimes divisiveness and tension due to different visions for the town.

- **Science**
  - Trust in science seems to vary depending on the issue.
  - People want a final number for buffer width recommendations. Ranges based on the pollution of concern (nitrogen, phosphorus, sediment, wildlife habitat, etc) contribute to the perception that buffers are arbitrary and the science isn't adequate.
  - There is generally a preference for engineered solutions over natural solutions and a sense that we can engineer around any obstacle.

- **Challenges for developers**
  - Inconsistency between communities makes it hard to know what to expect, for example, board personalities, relationships, level of expertise, and comfort level in asking questions and dealing with developers and consultants. Some communities are very resistant to growth and change. Conservation commissions are an especial wildcard because the degree to which they are involved and empowered in the decision-making process varies.
  - Navigating municipal, state, and federal regulations can be confusing and frustrating.
  - Developers feel like they don't have an avenue to get involved and don't trust the process.
  - One bad developer abuses the regulations and communities get gun-shy.

- **Trust and integrity**
  - Some feel regulations and the decision-making process lack integrity.
  - Regulations have unintended consequences.
  - Fear of risk or liability impedes innovation.
  - Wetland identification, evaluation, and delineation methodologies need to be trustworthy.
  - Consultants (wetland scientists and engineers) may face pressure in their decisions and develop reputations for being developer-friendly or not based on their work. Despite the certification requirements, competence among consultants can vary.
  - A history of mistrust and skepticism between stakeholders impacts decision-making. One community opinion leader or small group can direct or derail the process.
  - Transparency, trust, and relationships are critical.

D. PERSPECTIVES ON POLICY OPTIONS

The goal of the Buffer Options for the Bay project is to comprehensively understand the different approaches to buffer management that are used now and those that could be used in the future to encourage buffer use. In support of this, the team asked interviewees for their perspectives on state and local regulatory process for buffers. Questions and ideas that were associated with different buffer management options are summarized in the table below.

Option	Perspectives/Questions
Buffer widths	● Lack of understanding of different widths for different functions; complex ● Could buffer width be determined by hydrology? ● Not all wetlands are equal. Are small buffers even worth having?
No-clearing buffer	● Problematic (can result in clearing over a few years) ● Difficult to enforce
Overlay district	● The same buffer applies to everything – is there a way to treat buffers differently in particular areas of the community?
Prime wetlands	● Some fear everything will end up as prime, so they don't pursue designation.
Variable buffers	● *Communities B and D:* Arbitrary; seems more complicated; would lead to a larger battle between experts; boards don't want to have to push back against wetland scientists; might incentivize wetland scientists to deem a wetland low-quality so it would get a smaller buffer; some feel it's a fair compromise ● *External Stakeholders* have many different perspectives: o Cumbersome, confusing, requires much more technical expertise o Relatively simple, more reasonable than one arbitrary buffer o Some would rather have one buffer and educate decision-makers about reasons to waive the buffer in some cases o Mixed feelings about whether the science supports this approach o Depends on integrity of wetland identification,evaluation, and delineation
Cluster development	● *Pros:* Cost-effective; can save land and save money on infrastructure ● *Cons:* Perception that it burdens the land because of higher density "clusters"; lot dimensions aren't sufficient; minimum acreage doesn't always work

Option	Perspectives/Questions
Incentives	● Ideas: Performance incentives, tax breaks or refunds, density bonuses, transfer of development rights, buffer trading, incorporate into MS4 permit ● How would a tax break impact municipalities' budget/resources?
Other	● A utility seems like a more equitable approach ● Significant interest in allowing stormwater BMPs in exchange for reduced buffers; but many of these practices require long-term/perpetual maintenance, which does not always get done; some think mechanized design provides more opportunities to protect water quality than buffer restoration; stormwater requirements seem less controversial than buffers – developers feel they can recoup the costs of the engineered BMPs ● Municipalities are interested in looking into current use, transfer of development rights, residential-scale wetlands "banking," performance zones, and impact fees (question about open space restriction) ● Focus open space acquisition on buffers
Mitigation	● Some view the current approach (put upland elsewhere in conservation) as a land grab, think the ARM ratio is crazy; formulas are disingenuous ● Developers tend to like the in-lieu fee option (easier, more appealing than using part of the property to build a wetland) ● Need a better option, like LID ● Funds should stay local ● Make sure buffer restoration projects are eligible for ARM funding

Additional interview responses related to the current regulatory framework were grouped into the following topics:

- **Streamlining the permitting process**
    - It doesn't seem like there's a benefit to the lengthy, costly decision-making process. Developers want to reduce the costs of getting approval and developing the site. Funds saved through reduced site costs and streamlined process could support local projects.
    - Some want a one-stop-shop for all permits, or at least simplification or consolidation all of the wetland/shoreland regulations.
    - Municipalities could have a professional technical advisory committee, so all stakeholders meet early in an application process and discuss any potential issues and concerns.
    - The current process discourages improvements and innovations. If the process were streamlined, developers would put in BMPs and LID.
    - Other ideas: State review board instead of towns individually hiring their own engineers; upper-level board of communities to which developers can appeal.

- **State regulatory framework**
    - Stricter state regulations and stronger state support for municipalities and their ordinances are needed.
    - Shoreland Water Quality Protection Act (SWQPA): Generally, positive feedback; could be stronger, but at least provides some protection; consider translating SWQPA to wetlands.
    - There is a low rate of denial for state shoreland permits and a high "more information request" rate, especially for wetland permits; more outreach to get better applications is needed.
    - Generally, there is support for a statewide buffer—it would provide uniformity, clarity, and consistency; might help support affordable housing (allowing greater density/reducing costs of development); and at least provides a safety net for municipalities without a buffer.
        - The lack of a state buffer calls municipalities' buffer regulations into question. Municipalities want to feel that the state and courts support their ordinances.
        - Concerns: Would the statewide buffer supplant municipalities' buffers? Local rule is important in NH. Some think it would be easier to challenge local ordinances if there's a state buffer. Would communities use a science-based statewide buffer or continue to use their own buffer, which some perceive as being arbitrary or based on restricting growth? Would longtime residents be grandfathered into the rules?

- **"Thick" versus "thin" ordinance, "bulletproof" zoning versus case-by-case:** Some municipal stakeholders fear a lengthy ordinance will scare developers away (and the potential economic benefits that come from development in the community), but other statements indicate that there are advantages to a more detailed ordinance.
    - Municipalities with a clear, comprehensive ("thicker," longer) ordinance may have more stability and less staff/board turnover.
    - A clear ordinance helps developers know what to follow to avoid issues. A less clear ordinance leaves more up to interpretation and can create more gray area.
    - Clients think that municipalities with "thinner" regulations will be easier, but consultants tend to prefer "thicker" regulations. It's more predictable and easier to advise clients.
    - Developers want consistency with regulations but also flexibility in the review process, i.e., want to know what to expect and how to design a project, but not a 'one-size-fits-all' rule.
    - Granting lots of variances doesn't necessarily mean the regulations are too strict; it could mean the board or town has developed a permissive attitude toward the ordinance.

- **Other issues raised related to regulation**
    - Who is regulated? People tend to blame/focus on developers, but farmers and residents have an impact, too. Regulations should apply to landscapers and contractors, not just landowners.
    - How to implement a buffer when development is already there?
    - Wetland regulations are more controversial and difficult to comply with than shoreland regulations. This may be due in part to a broader awareness of the values of shoreland

versus the values of wetlands; the presence of state shoreland buffer requirements which delineate limits/permissions and provide some consistency, in contrast to wetland buffer regulations, which vary between municipalities and may lead to more discretionary decisions.
- Water doesn't follow political boundaries.
- Development of municipal ordinances tends to be retroactive (i.e., responding to issues as they arise)rather than proactive.
- How to deal with delayed and cumulative impacts?

E. COMMUNITY AND STAKEHOLDER NEEDS & OPPORTUNITIES TO SUPPORT THEM

In the course of the interviews, everyone was asked to reflect on what could be improved in relation to working with buffers, and they were also asked what kinds of resources would be helpful. This list reflects what the interview team heard from the interviewees, and has helped to inform the action plan being created for this project.

- **Municipal decision-making**

Process

- Hold regular "all boards" meeting to foster synergy, communication, and relationships.
- Designate a "quarterback" or municipal point-person to shepherd each project and keep other municipal stakeholders up-to-date or create a repository of project information/status.
- Build dialogue between municipal government and citizens.
- Need internal support for ordinance, decision-makers, and process.
- Conduct peer reviews for natural resource identification and evaluation.
- Consider a more formalized process for conservation commission involvement (some municipalities empower conservation commissions more than others).
- Having elected board members versus appointed members may work better.

Products

- Create a workflow of the municipal process to give to developers/applicants and use to identify communication/coordination opportunities.
- Create a checklist to make expectations for applications clear.
- Help communities develop a list of projects ready for ARM funding.

Capacity

- Hold trainings on buffers and LID for board members, especially ZBA and Select Board members (so they can support the other boards) and code enforcement officer.
- Encourage towns to hire an environmental planner.
- Empower boards to stand up for their ordinance/authority.
- Put a permanent conservation representative on the ZBA.
- Make municipal boards/staff aware of existing resources/services they can utilize.
- Create a ZBA training/advisory program and provide more guidance in ordinance for what ZBA should evaluate, especially regarding impacts on wetlands and buffers.

- Encourage boards to use legal counsel and provide trainings regarding case law and takings.
- Support maintenance of institutional knowledge and help them deal with turnover.
- Encourage municipalities to utilize their ability to bring in experts for review.

MS4 (Municipal Separate Storm Sewer System) permit

- MS4 permits could be a mechanism to incentivize buffers and raise awareness. Buffers are a low-cost, effective way to mitigate nutrient inputs. Need to better tie MS4 to wetlands.

- **Municipal ordinances**
  - Better definition of permitted and prohibited activities is needed.
  - Model ordinance: teach boards why it's written that way and how to implement it.
  - Incorporate a regular review of the ordinance.
  - Make sure ordinance backs up boards' right to seek external review.

- **Enforcement**
  - Elevate Code Enforcement Officer (CEO) role to emphasize monitoring and enforcing wetland/shoreland protections or consider an additional staff person focused on enforcing natural resource regulations.
  - Designate a shared CEO between multiple towns, dedicated to enforcing natural resource regulations.
  - State should inspect more permits after they are issued.

- **More information about**

Science

  - More information about isolated wetlands and the functions, values, and benefits of buffers for those wetlands is needed.
  - How far does pollution travel, for example, from septic systems?
  - Incremental benefits of increasing buffer widths—are there diminishing returns?
  - Tracking nitrogen loading impact of buffers is needed.

Economics

  - Does the open space benefit for property values make up for reduced number of lots?
  - More on property values and their connection to water quality and clarity is needed.
  - More on the tax implications of buffers, i.e., can you use the acreage of your property taken up by buffers as a "donation" on your taxes? How do buffers affect property taxes/values?

Policy and decision-making

  - Can stormwater BMPs be implemented in exchange for a reduced buffer?
  - Can we provide clarification and guidance for ZBA on making decisions about variances?
  - Look into the option of determining buffer width based on hydrology (flood elevation maps).
  - Explore enforcement questions and challenges.
  - Need to further explore incentives and other non-regulatory options.
  - Look at current use—minimum lot size is prohibitive; consider a similar but more inclusive program.

- Explore options to expand New Hampshire's impact fees policy to encompass open space preservation.
- Consider investigating the idea of a 'utility' or 'trading' approach for buffers.

Technical/mapping

- Provide more info about GIS data sources; wetland data sources don't line up; which to use?
- Buildout analysis—what a community would look like with different buffer widths.

- **Tools/resources that could be helpful**
  - Coherent story or synthesis of good information about buffers
  - A matrix with buffer-related management options with associated scientific information
  - Diagram of buffer or setback requirements; diagram of buffer widths for different purposes
  - Table comparing municipalities' buffers
  - FAQ sheet about why we have these regulations
  - More resources and clarification on making decisions about variances (e.g., hardship)
  - A "road map" or template for how to develop in difficult corridors with wetlands issues
  - More readily available zoning records
  - GIS (especially for code enforcement officers), and also more information about GIS data sources – wetland data sources don't line up; which to use? Note: GIS resources don't replace on the ground soil or wetland mapping for actual site/project design.
  - Aerial photo showing where resources are and the extent of development; then a buildout analysis showing how much you'd lose, impact of different buffer widths
  - GIS layer for NHDES permit applications (e.g., look at Subsurface Systems Bureau data for the number of new septic systems per year to identify development hotspots)
  - Low-cost recommendations for stormwater BMPs
  - Policy and guidelines for testing wells
  - Provide samples of approved permits and tools to determine when permits are needed
  - Interactive tool, internet platform, or app
  - Professional outreach materials about buffer regulations and the value of buffers
  - Presentations: use photos of old postcards of local water bodies to connect to the audience's memory and emotion and highlight change over time.
  - Webinars, Moodle (online trainings), and Prezi

- **Raising understanding/awareness**
  - Clarify and raise awareness about drinking water sources and quality; people value water resources but may not be aware of or understand the things that protect water quality.
  - Engage lake associations and watershed groups
  - Foster local champions (e.g., award/recognition for buffer-related work)
  - Municipality should lead by example

- **Potential motivations**
  - Limited water supply—can't afford to buy water from somewhere else
  - Tourism—need to protect our water

- Past water contamination issue in the community
- A community (and environment) we can be proud of is a better place to do business
- Humanize the values of buffers – flood storage, drinking water, property values
- Who's involved in a proposal makes a difference; community members or external experts?

- **Outreach to citizens**
  - Newcomers and new property owners are priority audiences for information and outreach.
  - Raise awareness about community's drinking water sources.
  - Connect citizens to local natural resources through access, engagement, and education.

- **Outreach to developers/applicants/contractors:**
  - Do more outreach on application requirements and process to foster better applications.
  - Do outreach to real estate firms, developers, landscapers, and contractors.
  - Educate contractors/builders on BMPs and the value of buffers.

F. COMMUNICATIONS

Stakeholder interviews were an excellent way to learn how to best to communicate about buffers. Key feedback the team received included the following:

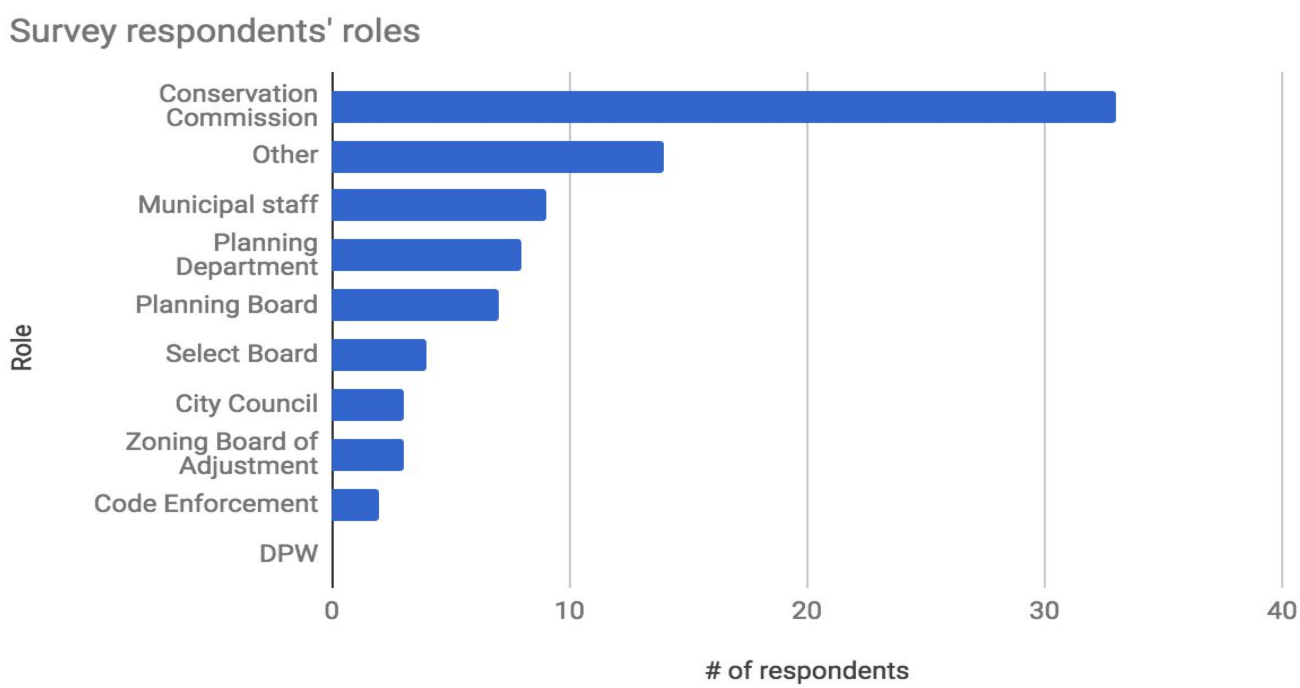
- Use what resonates: water quality, community benefits, clean water, space for children to play, financial connection, local level, and a shorter-term view.
- Understand what tends to not resonate widely: Habitat, wildlife, or the inherent value of nature.
- Focus on success stories; recognize the positive impacts developers have had, not just the negatives.
- Bring forward stories of egregious buffer impacts in the community.
- Clarify "buffers" and "setbacks."
- Show photos of buffers before and after restoration.
- Use every avenue for communication, e.g., social media, posters in municipal offices.
- Incorporate buffer-related topics into school curricula.
- Use first-hand experiences. There are different views about whether we can learn from other communities, i.e, "we're all in this together" versus "we can't relate to stories unless they're from truly comparable communities." There is a strong emphasis on communities' individuality and uniqueness.

III. Testing Subwatershed Findings For Broader Relevance

To test the findings of their assessment of stakeholder perspectives in four communities in the Exeter/Squamscott subwatershed, the BOB team conducted a survey of 42 municipalities in the Great Bay watershed. (All survey responses are compiled in Appendix E.) Survey questions were framed to assess whether the findings held true throughout the watershed or there were key issues that had not been captured. Recipients were asked to respond to 25 questions based on their experiences related to buffers in their town. Twenty questions were multiple choice with three options: *yes, no,* and *not that I recall.* Each asked whether a perspective that emerged in the subwatershed assessment had been witnessed or experienced in the respondent's community. Three questions were open-ended and two asked for individuals' roles and communities they represent. The survey was designed to take less than ten minutes to complete; the average completion time was ten minutes and seven seconds.

Survey Audience

The survey was emailed to individuals on the Great Bay National Estuarine Research Reserve Coastal Training Program's town-specific contact list of municipal officials, including Select Board or City Council members, Planning Boards, Conservation Commissions, Zoning Boards, Departments of Public Works, Code Enforcement Offices, and town administrators. The introductory email asked everyone to forward the email to peers, and the survey was sent out through several partner email contact lists, including the N.H. Association of Conservation Commissions, Piscataqua Region Estuaries Partnership, and University of New Hampshire Cooperative Extension. The survey was open for 2.5 weeks and 73 completed surveys were received.



"Other" write-in responses included: Local Land Trust (3,) Open Lands Committee (2), Private consultant (1), Consultant Planner (1), Former Conservation Commission (1), Local River Advisory Committee (1), Land Stewardship Committee (1), Energy Committee (1), Regional watershed group (1), State Rep./Rep to Lamprey River LAC/former Planning Board/former ZBA (1).

Communities represented by survey respondents: 73 Responses from at least 28 different municipalities (including three of the four CA focal communities)

# of respondents	Communities
7	Exeter
5	Portsmouth
4	Barrington
3	Dover Lee Madbury Newmarket Raymond
2	Brentwood Durham Fremont Greenland New Castle Stratham
1	Candia Hampton Hampton Falls Kensington Kingston *Kittery (ME)* Newington North Hampton Rochester Rollinsford Rye *Salisbury (MA)* Seabrook Wakefield
Others:	
9	No response
2	Multiple
1	Confidential Strafford and Rockingham Counties New Hampshire Lamprey River Watershed Neutral

Results

The survey results show overall strong watershed-wide agreement with the findings of the Exeter/Squamscott subwatershed assessment, with responses from a broad representation of types of stakeholders from at least 25 of the 42 N.H. municipalities in the Great Bay watershed. (More detailed responses are in Appendix E.) The table below shows the 20 buffer perspectives from the CA findings with the associated percentage of respondents who answered “yes” - that the perspective had been witnessed or experienced in the respondent’s community. The perspectives are ordered from highest agreement to lowest agreement, and color-coded by the following categories of percent agreement:

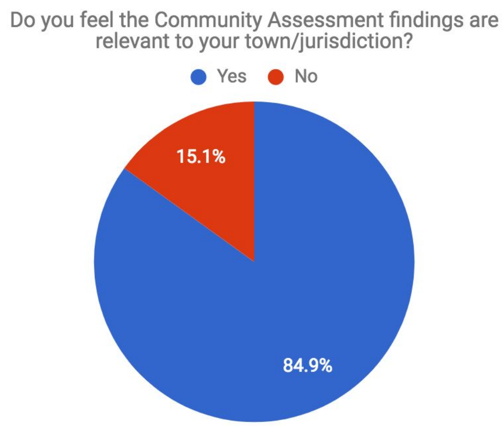
Very high agreement	80-100%	General agreement	40-60%
Strong agreement	60-80%	Weak agreement	<40%

Survey Query/Statement	% yes
Buffer-related decisions are inherently complex, requiring municipalities to balance many factors including property rights, community character, natural resource protection, abutters' concerns & economic growth.	94.52
People may not understand the individual and social benefits of buffers.	87.67
Buffer oversight and enforcement can be logistically difficult and lack capacity.	86.30
Developers want consistent regulations, flexibility in the review process, and not a 'one-size-fits-all' rule.	86.30
Some see buffers as an anti-growth policy.	78.08
Property rights are a major impediment to buffer protection.	77.46
It can be difficult to maintain and grow a sense of connection to the municipal history and values with changing demographics.	75.34
Buffer decisions are often perceived as a choice between natural resource protection and economic development.	75.00
Technical assistance is needed to show how to implement a buffer ordinance under the current development conditions.	75.00
Some fear that buffer regulations will prevent them from subdividing a property and maximizing its value for heirs.	73.97
Ordinances need better definition of permitted and prohibited activities.	67.12
Buffers have public benefits but buffer regulations don't affect all landowners equally.	64.38
There is an interest in allowing stormwater BMPs in exchange for reduced buffers yet BMP's require maintenance, and there is evidence that the maintenance does not get done.	61.11
Buffer-related applications should be evaluated on their merits, but municipal boards fear setting a precedent and getting sued which influences decision making.	60.27
There is generally a preference for engineered solutions over natural solutions, and a sense that we can solve any issue with an engineered approach.	57.53
Some feel buffer regulations and the decision-making process with buffers lack integrity.	53.42
Wetland regulations are controversial because they actually allow more flexibility, with discretionary approval or denial being dependent on site conditions.	50.68
The lack of a state buffer undermines municipal buffer regulations.	47.95
Survey Query/Statement	**% yes**
Buffer width ranges for various protections i.e. for nitrogen, phosphorous, flood control, or wildlife habitat contribute to the perception that buffers are arbitrary.	46.58
Dealing with buffers is more burdensome for homeowners than developers.	36.99

What are the biggest buffer management issues in your municipality?

There were 76 responses (some individuals described multiple issues). These responses correlate well with and support the findings of the CA. There were no new topics noticed in the responses to this question that were not already captured in the CA. See responses in Appendix E.

Do you feel the Community Assessment findings are relevant to your town/jurisdiction?



Key buffer-related perceptions that you have heard in your municipality that were not represented in this survey:

There were 34 responses, which broke into six categories. Of the responses, only a few were new or a new nuance of the buffer perspectives already captured in the CA. These include:

- Some believe that increased buffer regulation is a slippery-slope toward state rather than local control of town destiny
- A distrust of science and that buffers really don't matter
- It is the nibbling away at the edges issue that concerns me (e.g., homeowners that return for ZBA adjustments multiple times)
- People love buffers
- Some have talked about balancing the rights of the property owners vs. the public interest in resource protection, but I don't think it is as prevalent here as in other less liberal parts of the State.

IV. Appendices

Appendix A. Resources

State

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Winnicut River Subwatershed

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The Four Focal Communities

Resource	Chester	Exeter	Fremont	Stratham
Master Plan	X (2006, some chapters updated 2015)	X	X	X (1998)
Zoning Ordinance	X (2015)	X (2016)	X (2015)	X (2015)
Zoning Map	X	X	X	X
Community Profile	X (2015)	X (2015)	X (2015)	X (2015)
Community Survey	X (2015)			
Source Water Protection Plan	X			
New Hampshire's Changing Landscape Database	X	X	X	X
LRPP	X (2004)			
Conservation Focus Areas Map	X (2006)	X (2006)	X (2006)	X (2006)
Visioning Session	X (2015)		X (2013)	
Community Planning Assessment Report	X			
Stream Buffer Characterization	X	X	X	X

Natural Resource Inventory		X (2012)	X (2008)	X (2011)
Open Space Report			X (2010)	
Community Planning Roadmap			X (2010)	
Build-Out Analysis and Map	X (2008)			X (2004)
Water Resource Management Plan			X (2010)	X (1990)
Rockingham Planning Commission Map Sets		X	X	X

New Hampshire's Changing Landscape Database: http://clca.forestsociety.org/nhcl/data.asp

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Local

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Appendix B. Acronyms and Abbreviations Used

BOB	Buffer Options for the Bay
CA	Community Assessment
GBE	Great Bay Estuary
GBNERR	Great Bay National Estuarine Research Reserve
GIS	Geographic Information Systems
LID	Low-Impact Development
MS4	Municipal Separate Storm Sewer System
NH	New Hampshire

NHDES	New Hampshire Department of Environmental Services
PREP	Piscataqua Region Estuaries Partnership
TNC	The Nature Conservancy
UNH	University of New Hampshire

Appendix C. Methods

A. Planning Process and Input Opportunities

Developing the plan for this assessment was an iterative process that engaged the Buffer Options for the Bay (BOB) project team and its advisory committee. Steve Miller and Lisa Graichen began by drafting a work breakdown structure (Appendix D) that incorporated feedback from team members Cory Riley and Dolores Leonard. Steve and Lisa presented this at the second project team meeting and the first advisory committee meeting and documented input. An external (to the project) technical review panel also provided feedback, and Steve and Lisa documented their responses to the panelists' comments and questions. Team members had additional opportunities to provide input on the plan and the selection of the focal subwatershed and communities via email and a webinar. They also commented on preliminary assessment results at a subsequent meeting. Lisa and Team members Michele Holt-Shannon, and James Houle convened with advisory committee member John Coon to inform the analysis approach for interview data. (See Appendix E for documentation of feedback received on the community assessment.)

B. Community Assessment Timeline

2015

- Fall: Engagement team drafted Community Assessment plan
- November 9: Project Team meeting, received feedback on plan

2016

- January 21: Advisory committee meeting, received feedback on plan and subwatershed selection
- February: Technical review panel provided feedback on plan and subwatershed selection
- March 8: Subwatershed selection webinar with project team members
- March: Engagement team responded to input from project team, advisory committee, and technical review panel; finalized selection of the subwatershed and four focal communities
- May through August: Steve and Lisa conducted interviews; Lisa and Gabrielle MacIver (Carsey Fellow with NH Listens) (Michele's student) transcribed them;
- July 13: Project team provided feedback on preliminary results, reporting approach, and gaps
- July 26: Small group meeting to discuss community assessment analysis approach
- July through September: Transcribed interviews, analyzed results, drafted component synthesis
- September 19: Analysis meeting with Steve, Lisa, Jamie, and Michele
- Early October: Compiled survey feedback from project team and advisory committee
- October 13: Analysis meeting with Steve, Lisa, Jamie, and Michele
- October 18: Advisory committee meeting, feedback on preliminary results
- December 13: Project team meeting, presented final draft report of interview findings and

conceptual model
- January-February: Shared interview findings report with interviewees for verification

2017
- January: Second round of technical review
- January-February: Shared interview findings report with interviewees for verification
- Spring and summer: Tested findings from Exeter-Squamscott subwatershed with other communities throughout the Great Bay watershed

C. Subwatershed and Community Selection

In the grant proposal funding this assessment, we indicated we would focus our work on one or two subwatersheds and three to five communities within these. We decided it would be the best use of our time and capacity to focus on one subwatershed and dig into four of its communities, rather than cover two communities in two subwatersheds. We began with the list of communities that comprise each subwatershed as delineated in the *2015 Piscataqua Region Environmental Planning (PREPA) Report*. However, if a community fell substantially in two different subwatersheds, we considered that community in both lists for the purposes of evaluating subwatersheds based on project needs. We also focused on New Hampshire communities, though there are ten Maine communities in the Great Bay watershed.

With input from the project team and advisory committee members, we determined that the subwatershed should include a group of communities that has the following characteristics.

1. **Show differing levels of progress in terms of buffer-related regulations**, based on the 2015 PREPA report cards for shoreland protection and freshwater wetlands. Team members were interested in learning about the barriers faced by those communities making less headway (according to PREPA) and the successful experiences of the higher performing communities.

2. **Include both MS4 (Municipal Separate Storm Sewer System) and non-MS4 communities (or those with a waiver).** The team wanted to understand whether there are differences in the perspectives, challenges, and opportunities related to buffers between communities that are regulated under this program and those that are not.

3. **Are geographically diverse.** The team wanted to characterize differences in the perspectives, values, and opportunities between the more inland communities and those closer to the bay.

Based on these criteria, the Lamprey River and Exeter-Squamscott subwatersheds rose to the top of our list. We reviewed GIS work conducted by project team member Pete Steckler from the New Hampshire Chapter of The Nature Conservancy to identify areas within the Great Bay watershed with the greatest opportunity for protecting buffers. Subsequently, our technical team identified the Exeter-Squamscott, Oyster-Bellamy, and Winnicut River subwatersheds as their top options given that these all have large areas that have been identified as important for salt marsh migration and significant opportunities for buffer protection or restoration adjacent to both tidal and freshwater riparian habitat. Ultimately, we selected the Exeter-Squamscott subwatershed because of the overlap between our criteria for community context and the technical team's priorities.

We then dug into the characteristics of communities within these subwatersheds to identify three or four on which to focus. We considered where there have been recent or ongoing projects. For example, several communities were working on buffer ordinances through PREPA grants and we hoped to learn about those efforts. However, we also wanted to look at those that hadn't received as much technical assistance or outreach and those with varying characteristics, including population density, per capita income, impaired waters, type of drinking water source, presence of a watershed committee, and presence of important agricultural soils.

Our goal was to identify communities with enough diversity to enable us to learn about buffers in a range of contexts and see what might be common and what might be unique about their approaches to buffer management and the challenges and opportunities. Our technical team had suggested Newfields, Stratham, Newmarket, and Exeter as potential communities, and we decided to include Stratham and Exeter, but also Fremont and Chester in order to reach further inland/upper watershed and less developed communities.

Table 1. Summary of Subwatershed Assessment Against the Major Criteria

Subwatershed	**# of towns**	**Major criteria**			
		Mixed levels of progress with shoreland protection?[1]	**Mixed levels of progress with freshwater wetlands?**[1]	**Mix of MS4 and non-MS4 communities? (2013)**[2]	**Geographic mix of communities, i.e., close to Great Bay and further inland?**[3]
Lamprey	12	Yes	Yes	Yes (2 MS4, 2 waiver, 3 non MS4)	Yes
Exeter-Squamscott	13	Yes	Yes	Yes (6 MS4, 5 waiver)	Yes
Coastal	8 (NH)	Yes	Mostly low levels of progress	Yes (3 MS4, 1 waiver)	No
Oyster-Bellamy	5	Yes	No	Yes (1 MS4, 2 waiver)	Some
Hampton-Seabrook	5	Mostly low	Mostly low	Yes (2 MS4, 1 waiver)	No

Table 1. continued. Summary of Subwatershed Assessment Against the Major Criteria

Subwatershed	# of towns	Major criteria			
		Mixed levels of progress with shoreland protection?[1]	Mixed levels of progress with freshwater wetlands?[1]	Mix of MS4 and non-MS4 communities? (2013)[2]	Geographic mix of communities, i.e., close to Great Bay and further inland?[3]
Salmon Falls	7 (NH)	No	Mostly low	Yes (2 MS4, 3 non)	Yes
Winnicut	3	No	No	No (2 MS4)	No

1. Piscataqua Region Estuaries Program, 2015 Piscataqua Region Environmental Planning Assessment, http://prepestuaries.org/prepa/

2. Information retrieved from: https://www3.epa.gov/region1/npdes/stormwater/nh.html

3. Based on a visual assessment

Table 2. Additional Criteria to Inform the Selection of Focal Communities within the Exeter-Squamscott Subwatershed

Exeter-Squamscott subwatershed	PREPA 2015: Shorelands[1]	PREPA 2015: Freshwater Wetlands[1]	MS4 Mix[2]	Geographic mix[3]	Pop. density (people per sq. mi)[4]	Per capita income[4]	Impaired waters[5]	Exeter River as drinking water supply?[6]
Brentwood	45	17	Waiver	Inland	267.2	$37,506	Yes (AL)	
Chester	25	33	Waiver	Inland	184	$39,816		
Danville	5	0	Yes	Inland	378.5	$31,443		
East Kingston	20	0	Waiver	Inland	250.5	$39,366		
Exeter	75	50	Yes	Inland/close to Great Bay	728.1	$37,972	Yes (AL, PCR)	Yes
Fremont	75	50	Waiver	Inland	250.5	$36,331	Yes (AL)	
Kensington	5	0	Yes	Inland	175.8	$49,435		
Kingston	55	100	Yes	Inland	305.1	$37,266		
Newfields	50	0	Waiver	On GB	230.5	$50,700		
Newmarket*	20	50	Yes	On GB	710	$32,244	Yes (Lamprey – AL, PCR, SF, FC)	No (Lamprey)
Raymond*	0	0	Yes	Inland	353.2	$27,755	Yes (AL)	
Sandown	0	17	Yes	Inland	434	$37,507	Yes (AL)	
Stratham	20	0	Yes	On GB	481.8	$56,550	Yes (AL, PCR, FC, SF)	

1. Piscataqua Region Estuaries Program, *Piscataqua Region Environmental Planning Assessment 2015, http://prepestuaries.org/prepa/*
2. Information retrieved from: https://www3.epa.gov/region1/npdes/stormwater/nh.html.
3. Based on a visual assessment.
4. From 2015 Community Profiles, Economic and Labor Market Information Bureau, NH Employment Security.
5. From NHDES 2014 draft list of threatened or impaired waters that require a TMDL (10/14/15); Aquatic Life (AL), Primary Contact Recreation (PCR), Shellfishing (SF), Fish Consumption (FC).
6. From NHDES Drinking Water Source Assessment Program: retrieved from: http://des.nh.gov/organization/divisions/water/dwgb/dwspp/reports/index.htm

The four highlighted municipalities are those selected for the focus of the community assessment.

* = Addition to PREPA's list of communities in the subwatershed.

Once the focal subwatershed and communities were selected, we compiled resources specific to the subwatershed and municipalities (see Appendix A). These resources were used to develop profiles that summarized the communities' approaches to buffers and prepare for the interviews. In addition, we assessed the four communities' ordinances by comparing to the PREPA report and New Hampshire Department of Environmental Services (NHDES) model ordinances.

We then conducted interviews with 38 stakeholders to gain a more in-depth understanding of the buffer-related decision-making process at the local level, perspectives and preferences, and challenges and opportunities related to both regulatory and nonregulatory approaches, as well as implementation. We compiled relevant resources, such as zoning ordinances, from all watershed communities, with a focus on those in New Hampshire. We developed a simple inventory of the municipalities' shoreland and wetland buffers. Since specific ordinances are complicated and difficult to compare to each other, we grouped these into three general categories: 1) no cut-no disturbance buffer, 2) limited cut or managed buffer, and 3) no buffer and captured the width of the buffer. This did not include setbacks.

D. Interview and Analysis Process

Identifying interviewees

Steve Miller and Lisa Graichen visited the four town halls to introduce the project and establish initial connections. We asked our initial points of contact for suggestions for municipal representatives (staff and board members) whom we should interview about buffers. We reached out to these stakeholders via email to describe the project and the interview. In several cases, one town representative would make the connection via email for us. During each interview, we asked for suggestions for further interviewees and continued this process. In addition to the municipal representatives, we also interviewed other stakeholders involved with buffer-related decisions in their work and have familiarity with the focal towns. These stakeholders included engineers, wetland scientists, planners, and developers. These interviewees were suggested by the municipal representatives we interviewed and identified by searching meeting minutes from the focal towns. Especially with the developers, we found more success in scheduling interviews if another interviewee made the connection for us. Here is a summary of the types of stakeholders we interviewed in the four communities:

Interviewees: Distribution of Roles		
13 Municipal staff:	**10 Municipal board members:**	**15 Other stakeholders:**
● 4 Code enforcement officers ● 4 Planners ● 3 Town administrators or managers ● 2 Other	● 4 Conservation commission members ● 2 Planning board members ● 2 Zoning board members ● 2 Select board members	● 4 Engineers ● 2 Wetland scientists ● 3 Developers ● 4 Regional planners ● 2 Other outreach and technical assistance providers

Interviewees: Demographic Information (not self-reported)
11 female, 28 male 100% Caucasian

We continued the interviews until we felt a sense of triangulation and suggestions for additional interviewees were redundant. In total, 38 individuals were interviewed in 28 interviews (some interviews included multiple individuals). We presented our progress and preliminary findings to the project team in July 2016, and while a few gaps were noted (namely landowners, especially agricultural), we were advised to analyze the transcripts we had thus far and decide whether to conduct more interviews (and if so, with whom).

Interview Approach

We developed a list of questions to guide the interviews based on the goals of the project—and community assessment component in particular—as well as feedback from the project team, advisory committee, and external technical review panel. The interviews were generally semi-structured, with some falling more into the unstructured category. We began each with an overview of the project, the purpose of the interview, and a description of how the information would be used. We then asked if they were okay if we recorded the conversation. Recording enabled us to fully participate in the interview, knowing that we could transcribe the recording later. All but two interviews were recorded.

Lisa and Steve conducted most interviews together, though Lisa conducted five and Steve conducted four independently. Most interviews were with one person to try to ensure he or she was comfortable describing his or her perspectives. However, there were several instances with two, three, or four interviewees in the same conversation. We agreed to these because we wanted to be respectful of their time, we wanted to engage as many people as possible, and if a joint interview was preferable to the interviewees, we wanted to accommodate that preference.

The questions varied depending on the interviewee's role, since their involvement with buffer-related decisions varied; some were, for example, conservation commission members, while others were engineers. We also would adapt the conversation to include particular questions we had about the municipality the interviewee represented, including, for example, specific questions about the town's zoning ordinance. The interviews were largely unstructured because we wanted to allow the interviewee to discuss the ideas, issues, and stories that came to mind. We also wanted the flexibility to ask additional questions that arose. We had fluid, rich, and candid conversations that ranged from about 45 minutes to more than two hours, though typically they were in the 90-minute range. Below are lists of the types of questions we typically asked of the municipal and consultant interviewees.

Questions for municipal stakeholders (staff and board members):

1. How long have you lived in Stratham?
2. How long have you been in your current role for the town, and have you served on any other boards or committees in the past?
3. How would you describe Stratham, what would you say are the major values or characteristics that are important to the town? Have there been any changes over time?
4. What does the decision-making process look like when you get an application that impacts the buffer? Could you walk us through the process, i.e, who's involved, what are the steps, what are the questions that you ask? What is your role in the process?
5. Confirmed our understanding of the Zoning Ordinance components related to buffers, then asked if there are any other components that relate to buffers.
6. How well do you feel the current regulatory framework is working? What works well, and what doesn't?
7. What are the major challenges to implementing buffers?
8. What could be improved (in the ordinance or implementation)?
9. Are there any non-regulatory approaches (like incentives) that you think might work here?
10. Are there any resources (information, content or mechanism, funding, training, assistance, etc.) that would be helpful in improving buffer management?
11. Stratham is on the most recent list for MS4 regulated communities—is there any consideration of buffers in relation to meeting these permit requirements?
12. Is there anything else you'd like to share?
13. Who else should we talk to?

Questions for other stakeholders (engineers, wetland scientists, etc.):

1. What is your professional role? How long have you been doing this kind of work?
2. What is the geographic scope of your work?
3. What types of clients do you work with?
4. Can you describe for us what a typical project looks like and what your involvement is?
5. Do you have any experiences with Chester, Exeter, Fremont, or Stratham?
6. Have you noticed any differences in terms of how buffers are managed or how these decisions are made in different communities? If so, have you noticed any factors that contribute to successful buffer management or good decision-making processes?
7. Do you have any perspectives about the buffer management options that communities in this area tend to employ (what works well/what doesn't)?

8. Have you noticed any changes over time (in approaches to managing buffers, decision-making process, etc.)?
9. Do you deal with the state regulatory framework in your work? If so, is it challenging to navigate the overlap between municipal and state processes? Are there any opportunities for improvement there?
10. What are some of the perspectives or concerns about buffers that you hear from clients/stakeholders?
11. What are the challenges related to buffers in your work? What do you think could be improved? (e.g., buffers would work better if communities had ____ resources or capacity, or if municipal board members had training in ____)
12. Are there resources related to buffers that would be helpful in your work?
13. Is there anything else you'd like to share?
14. Who else should we talk to?

Recordings were uploaded to a computer and named using a standard filing system. Lisa transcribed the first ten interviews, and Gabrielle MacIver transcribed the remainder. Transcriptions were shared between a limited number of project team members through a shared Google Drive folder. Care has been taken to protect interviewees' confidentiality. Only the component leads and community assessment analysis team members have access to the transcriptions, and the initial analysis steps done by Lisa and Steve will result in a degree of separation between the findings and the source.

Analysis Process

The analysis process was informed by Grounded Theory methods for qualitative research (Birks and Mills, 2011; Charmaz 2006; Corbin and Strauss, 2015; Goulding 2002; and Houle 2015). Lisa developed a memo for each interview by reviewing the transcript and any notes from the interview then writing a summary of the key themes, capturing demonstrative quotes where useful, and recording reflections and insights where they arose. Through an iterative process of condensing these memos, Lisa developed a spreadsheet of all of the ideas from each memo, maintaining the identifying interviewee number as well as the category identifying the type of stakeholder. In order to keep some distance between the specific interviewee and the findings, we assigned the following categories:

- Internal (within a municipality)
    - Professional (e.g., staff)
    - Volunteer (e.g., unpaid board members)

- External (not within a specific municipality)
    - Professional (e.g., wetland scientist, engineer, developer, planner, etc.)

A small group (Steve, Lisa, Jamie, and Michele) convened to discuss the findings, using post-it notes with each idea from the memos, with those from "internal" interviewees color-coded to identify the associated community. We then began organically grouping similar ideas and continued until all ideas were assigned a category. We organized the "internal" interviewees' ideas first, and then the "external" interviewees' ideas. For the external interviewees, we did not force the same categories from the internal round, but many of the same categories emerged. After all of the post-it notes were sorted, Lisa created a spreadsheet compiling the results of the categorization. From there, Lisa worked through each category, condensing like ideas and describing higher-level themes. Eventually, a summary of the key themes from the interviews emerged, and Steve, Jamie, and Michele reviewed the draft to provide feedback. Finally, the draft summary was sent to all of the interviewees for verification in early 2017.

E. Approach: Testing Subwatershed-level Results for Broader Relevance

Purpose of the Watershed-Wide Vetting survey

The Community Assessment (CA) was based on interviews with municipal board members and staff, as well as other stakeholders, in four municipalities in the Squamscott/Exeter subwatershed of the Great Bay watershed. This document is a report of the vetting of those results throughout the larger Great Bay watershed of 42 municipalities. The survey (all survey responses compiled in Appendix E) was developed to find out the extent to which the findings of the Buffer Options for the Bay (BOB) Community Assessment are representative of all the Great Bay municipalities, to see if the key findings broadly hold true, and to find out if there were key issues regarding buffers that are not captured in the CA. The survey asked municipal representatives who were not part of the CA process to answer 25 questions based on their experiences and what they have directly witnessed or experienced in their town regarding buffers and buffer perspectives. Twenty of the survey questions were multiple choice with three simple options (yes, no, not that I recall), asking whether the buffer perspective (from the CA findings) presented in the question had been witnessed or experienced in the respondent's community. Three questions were open-ended questions, and the last two questions asked for individuals' roles and communities they represent. The survey was designed to take less than ten minutes to complete, and the average time to complete the survey was ten minutes and seven seconds.

Survey Audience

The survey was emailed to individuals on the Great Bay National Estuarine Research Reserve Coastal Training Program's town-specific contact list of municipal officials (including Select Board or City Council members, Planning Board, Conservation Commission, Zoning Board, Department of Public Works, Code Enforcement, and town administrators). In the introductory email, we asked everyone to forward the email to peers, and the survey was sent out through several partners' email contact lists as well (N.H. Association of Conservation Commissions, Piscataqua Region Estuaries Partnership, UNH Cooperative Extension). The survey was open for 2.5 weeks, and 73 completed surveys were received.

Appendix D. Work Breakdown Structures

Subwatershed Selection Overview and Work Breakdown Structure (November 23, 2015)

Why are we doing this?

We are selecting a subwatershed to dig deeper into the barriers, perspectives, and opportunities related to buffer management at the local level. The project team and Advisory Committee will contribute to the selection of one subwatershed and 2-4 communities within that subwatershed. The Community Assessment, and perhaps some additional GIS work if needed, will then focus on those communities.

How will we do it?

There will be several layers of input into the subwatershed selection process. We are conducting some preliminary scoping (looking at existing resources, talking with colleagues, and perhaps sending a survey to municipal officials throughout the watershed to gauge needs and interest). Based on these efforts, we will develop a set of criteria and supporting materials for the selection process. We will give the project team an opportunity to vet the criteria and supporting materials, and also to suggest subwatersheds and communities to work with based on their experience (and any watershed-scale analysis results that are available by that time). Then we will engage the Advisory Committee at the January 13th meeting to get their feedback on the selection criteria and their suggestions for subwatersheds and communities. We will document and compile all suggestions then work to select the subwatershed and communities most supported by the AC and project team and those that best fit the criteria.

Steps and timing (see WBS below for more details)

1) Conduct preliminary watershed-scale community assessment to inform the process (Sept. – Dec. 2015)
2) Get input on selection criteria from project team members (11/9/15); proceed with preliminary evaluation of subwatersheds based on these criteria to present to Advisory Committee (Nov. 2015 – Jan. 2016)
3) Get input on selection criteria and suggestions from AC (January 2016)
4) Incorporate AC feedback; finalize selection of subwatershed and communities (Jan. – Feb. 2016)
5) Invite communities to participate and invite representatives to join the AC (February 2016)
6) Implement Community Assessment (see Community Assessment WBS for more details)

Progress to Date

- Compiled PREPA report information to help with selection
- Conducted several informal interviews to inform the process
- Compiled/updated contact information for municipal officials/board members (still some gaps)
- Started compiling ideas for criteria; discussed criteria at 11/9 project team meeting
- Started initial evaluation of subwatersheds against draft criteria to present to AC for feedback

Next Steps

- Finish preliminary evaluation of subwatersheds
- Provide opportunity for project team input on criteria/preliminary recommendations
- Prepare for selection process at 1/13 AC meeting (e.g., preparatory material to send in advance)

SUBWATERSHED SELECTION: work breakdown structure	
1. Framing	**1.1 Conduct Preliminary Watershed-scale Community Assessment/Scoping** ● Compile available resources (e.g., PREPA) related to municipalities' buffer protection status ● Conduct informal interviews with colleagues working throughout the watershed to get ideas for criteria and initial suggestions for subwatersheds or communities to consider ● Compile ideas for criteria to guide this decision ● Compile contact list of municipal officials/board members in the watershed (for sending surveys in the future and for following up with the selected communities) ● May develop survey to send to municipal reps throughout the watershed to gauge need/interest ● Develop resources (e.g., brief report on results of this initial scoping, maybe maps?) to support the feedback process with both the project team and Advisory Committee ➢ **Level of effort and timing:** 40 hours; September through December 2015 ➢ **Responsible:** Lisa and Steve ➢ **Dependencies on other parts of project:** If there are any watershed-scale GIS results available by January 2016, it would be helpful to integrate that with the subwatershed choice (e.g., where are the areas of greatest need or the opportunities for greatest impact)

2. Doing	**2.1 Get Project Team's Input on Subwatershed Choice** ● Send draft criteria to the project team for review ● Offer opportunity for project team to suggest subwatershed/communities ● Revise resources for AC based on feedback and compile suggestions to consider as ➢ **Level of effort and timing:** up to 5 hours; November – December 2015 ➢ **Responsible:** Lisa? ➢ **Dependencies on other parts of project:** Project team members' input will be informed by what they need for their components **2.2 Get Advisory Committee's Input on Subwatershed Choice** ● Send preparatory materials related to subwatershed choice to Advisory Committee in preparation for the 1/13 meeting ● Develop agenda and facilitation plan to support this component of the 1/13 meeting ● Conduct 1/13 meeting – vet selection criteria with AC and get their suggestions for a subwatershed and communities to work with; compile notes and offer opportunity for AC and project team to review ➢ **Level of effort and timing:** 10 hours, including 1st AC meeting (overlaps with AC engagement WBS); December 2015 – January 2016 ➢ **Responsible:** Steve and Lisa ➢ **Dependencies on other parts of project:** Resources to send to the AC to prep for 1/13 meeting may be informed by any watershed-scale results available by that time; need project team's participation in 1/13 meeting **2.3 Incorporate Feedback and Recommendations from Project Team and Advisory Committee to Select the Subwatershed and Communities** ● Compile suggestions from project team and AC ● Look for consensus or majority opinion on which subwatershed and communities should be selected ● Report back to project team for final opportunity to review (if needed) ➢ **Level of effort and timing:** up to 5 hours (process to resolve choice depends on degree of consensus); January 2016 ➢ **Responsible:** Steve and Lisa, coordinating with other component leads as needed ➢ **Dependencies on other parts of project:** The final decision process may be dependent on the range of input received from the AC and project team – if there is general consensus about the subwatershed and communities to choose, this will be a simple process; if not, we may need to go back to the component leads or full project team to work through any major differences of opinion.

3. Wrapping Up	**3.1 Report back to the Project Team and Advisory Committee on the Results** ➢ **Timing:** February 2016 ➢ **Responsible:** Lisa (maybe coordinating with Dolores on a BOB update to the project team) **3.2 Adapt Community Assessment Plan as needed** ● Refine plan according to the selected subwatershed and communities ● Invite communities to participate and invite several representatives from the subwatershed and communities to join the Advisory Committee (send them resources to get up to speed) ➢ **Level of effort and timing:** up to 5 hours; February 2016 ➢ **Responsible:** Steve and Lisa

Community Assessment Overview and Work Breakdown Structure (November 23, 2015)

Why are we doing this?
The community assessment will help us better understand the barriers, opportunities, values, perspectives, and social/political context related to buffer management. By focusing on 2-4 communities within one subwatershed, we aim to get an in-depth understanding of the context for buffer-related decisions at the local level. This component will yield a summary report and will feed into the "clarifying the issue" synthesis. The results will also inform the option evaluation stage, as we will have an improved understanding of what may or may not work in certain communities and why.

How will we do it?
Once the subwatershed and communities have been selected, we will reach out to members of the communities (e.g., municipal officials or other contacts we might have) to invite them to participate. We will use the following methods in the community assessment:

- Review existing resources (e.g., master plans and newspapers) and identify existing community groups (e.g., a local watershed group)
- Observe relevant community meetings (e.g., conservation commission and planning board meetings) and review meeting minutes
- Conduct interviews and surveys
- Conduct focus groups
- Employ stakeholder mapping methods (e.g., Susan Clark's *Policy Process*)

We anticipate engaging municipal officials and board members (e.g., selectmen, planning board members, conservation commission members, etc.), as well as individuals involved with local watershed or conservation organizations, developers, consultants, and other stakeholders as needed. We will use stakeholder mapping to identify the community members involved with and/or affected by buffer-related decisions and guide our investigation into their knowledge, attitudes, perspectives, and values.

Steps and timing (see WBS below for more details)

1) Develop community assessment plan and get project team and AC feedback. (Sept. 2015 – Jan. 2016)
2) Once subwatershed and communities have been chosen, refine the assessment plan as needed and compile resources specific to those towns. (Jan. – Feb. 2016)
3) Implement the community assessment plan in each community, documenting findings and lessons learned along the way. Methods will include review of existing resources (e.g., master plans); observing relevant community meetings (e.g., conservation commission meetings); conducting surveys and interviews with municipal officials, landowners, and other stakeholders; and conducting two focus groups in each community. Share progress with team as needed. (Feb. – April 2016)
4) Analyze results, draft community assessment report, and share with project team and AC. Incorporate findings with development of final products. (May – Sept. 2016)
5) Follow up with communities to share results of project. (Sept. 2017?)

Progress to Date

- Drafted community assessment plan; presented to project team 11/9
- Developed criteria for subwatershed/community selection, within input from some project team members at 11/9 meeting; started evaluating subwatersheds against those criteria

Next Steps

- Continue to prep for implementation
- Get feedback from AC on community assessment plan and subwatershed/community selection criteria/recommendations (Jan. 2016)
- Refine plan once subwatershed and communities are selected
- Invite representatives from the subwatershed/communities to join the Advisory Committee once selected

COMMUNITY ASSESSMENT: work breakdown structure	
1. Framing	**1.1 Develop Community Assessment Plan** ● Draft plan, get feedback from project team (11/9) and AC (1/13); revise as needed ● Develop materials for surveys, interviews, and focus groups, and guidance for meeting observation ● Invite communities and refine plan based on subwatershed/communities selected ➢ **Level of effort and timing:** 20 hours; September 2015 – January 2016 ➢ **Responsible:** Steve and Lisa, with input from Michele and Jamie ➢ **Dependencies on other parts of project:** Feedback from project team members on the plan **1.2 Select Subwatershed and Communities** ● (See subwatershed selection WBS for more details) ➢ **Level of effort and timing:** 40 hours; October 2015 – January 2016 ➢ **Responsible:** Steve and Lisa, with input from Jamie (Diffusion of Innovation) and other project team members ➢ **Dependencies on other parts of project:** Ideally some input from the GIS work about the opportunities for greatest impact
2. Doing	**2.1 Implement Community Assessment Plan** ● Compile existing resources for the communities selected ● Begin stakeholder mapping for the communities to identify specific community members that need to be engaged and set up the framework for investigating their perspectives, values, etc. ● Determine which community meetings will be relevant to attend and find out schedule/contacts; collect past meeting minutes ● Conduct interviews, surveys, and focus groups ● Compile/organize data, document lessons learned, share progress with team ➢ **Level of effort and timing:** 200 hours? January – February 2016 review existing resources and prep for engagement in communities; March – April 2016 conduct interviews/surveys/focus groups ➢ **Responsible:** Steve and Lisa, with support from Michele on focus groups ➢ **Dependencies on other parts of project:** May need some information/resources from the literature review and mapping work to use in community meetings **2.2 Analyze Results and Develop Report** ● Analyze existing resources, survey data, interview transcripts/notes, focus group notes/products, meeting observation notes, etc. ● Draft Community Assessment report ➢ **Level of effort and timing:** 20 hours; May through August 2016 ➢ **Responsible:** Lisa and Steve ➢ **Dependencies on other parts of project:** Just staying up to date with other components' progress and results to ensure our analysis and reporting is most relevant and useful to the project team

3. Wrapping Up	**3.1 Share Findings/Report with Project Team and Advisory Committee** ● Share draft report and findings with project team and discuss integration with other project components ● Present findings at September 2016 AC meeting (preliminary results conference) ● Revise report based on feedback ➢ **Level of effort and timing:** 5 hours; August – September 2016 ➢ **Responsible:** Lisa and Steve ➢ **Dependencies on other parts of project:** Just staying up to date with other components' progress and results to ensure our presentation of findings is **3.2 Integrate Community Assessment Findings with Evaluation of Options Process and Development of Final Products** ● Make sure relevant findings from Community Assessment inform the process of evaluating options with the Advisory Committee and the development of final products ➢ **Level of effort and timing:** 5 hours; September 2016 – July? 2017 ➢ **Responsible:** Lisa and Steve, collaborating with Dolores on final products ➢ **Dependencies on other parts of project:** Overlaps with the Advisory Committee work (Steve and Lisa also responsible) and with the product development work (Dolores and Cory) **3.3 Determine Appropriate Follow-up with Communities Involved** ● This could be another meeting to present the results of the Community Assessment (i.e., September 2016), or the results of the whole project (September 2017) ➢ **Level of effort and timing:** TBD ➢ **Responsible:** Lisa and Steve ➢ **Dependencies on other parts of project:** May want some participation from other project team members at these follow-up presentations

Appendix E. Documentation of Feedback

Project Team meeting, November 9, 2015

Afternoon Breakout re: subwatershed selection criteria and resources – Steve M., Jamie, Michele; Cory, Simone, Steve C. joined later

- Michele – which towns have more people <30 years old (disproportionate aging is an issue in NH) → resiliency for decision making, maybe economic component (Dover, Durham vs. Exeter)
    - Assumption – community demographics (age) impacts decision making
    - Jamie – lots of general work (younger – more innovative, progressive), but when it gets to a specific item (like managing buffers), demographics likely less important; small cross-section of community is involved in local decisions (tend to be older)
- Base it on connection already demonstrated, what colleagues have noticed (re: willingness)
- Jamie – specifically target what we want out of this study
- Cory: 1) Community context – what does it look like around Great Bay (PREPA) (influences Implementation Plan); 2) Subwatershed selection/community assessment – opportunity for additional work to get them over the hump (e.g., land trust, technical assistance)
    - Needs Assessment – barriers, opportunities, motivating factors
    - Typologies → test elsewhere
- Representativeness? Barriers are going to be very community-specific
    - Ask about typical local barriers as well as specific (jump start for implementation plan)
- What do we need to know about these communities to do work effectively?
- Need an operational definition of "success" (communities – leading); early success + capacity; PREPA + lit review; open space plan; long-term – habitat/WQ protection, flood attenuation
- Opportunity + high-value combos – what's already out there, where we could learn the most
    - Local context + partner intervention opportunities
    - Land + history of working together
- Thinking at subwatershed level – makes sense but doesn't happen at municipal level; land conservation does take it into account (connectivity); what can partners do to fill those gaps?
- Look at local and regional master plans
- Potential criteria:
    1. Upper watershed + lower (distance from Great Bay; opportunities)
    2. MS4/non-MS4
    3. One or more communities with a lot of work to do, or one that has tried and keeps failing
    4. Urban/rural
    5. Need to capture town effort, success/failure – want a range
- Write out assumptions – what we think we are going to get out of these criteria?
- Better to have a range – help products be more informative
- Oyster River subwatershed would be tough
- Steve C. – rural/urban not primary criteria for me, but upper/lower yes
    - Greenland – failure on buffers; interesting community in lower watershed
- Abutters of Great Bay or riverine?
- Which criteria trump others?
- Squamscott or Lamprey; Exeter – Brentwood/Danville
- Winnicut has a lot of activity already (watershed-wide plan)
- Look at what other work is going on, capacity
- Approach: Interview – focus group – interview (skip initial interviews when we can – efficient)

- Start with administrator, staff, planner → who should we talk to (who works on buffers)
  - Will be more complicated in larger communities
  - Phone calls to gauge interest?
- Selection process:
  - PREPA → segment, cross-section; overlay with GIS results → select communities
  - Develop selection process hypothesis
  - Criteria → AC, tech review
- Policy – state level + other states → what are the options right now for towns/state agencies
- Could that work here? How do we translate options to NH?
- Helpful to have state rep. → from communities selected
- Check with Kirsten Howard – PREPA maps/data? How far along each town is – color-coded
- Touch base with technical team
- Resources: Vesey dissertation; RPCs – good source of information

Advisory Committee meeting, January 21, 2016

Discussion re: Subwatershed Selection

- Michele: Our project defines Stratham as part of Winnicut watershed.
  - *Jamie: We won't ignore communities because they may be defined as part of watershed differently.*
  - Julie: Perhaps we could have some communities that are crossovers.
  - Tin: And state of Maine. ☺
- Ruth: In terms of the size of subwatersheds, might look for one with more options (more communities).
- Julia: Why isn't willingness to participate higher, doesn't it limit everything?
  - *Lisa: Planning to rank based on the criteria and then see who will work with us.*
- Is it your goal that you will pick a subwatershed and that all communities will participate?
  - *Lisa: Our goal is to work in ideally 4 communities within a subwatershed, look for consistencies and areas where communities are distinct. We may also look at testing what we learn in other areas of the watershed.*
- ?: What about having what percentage of river is tidal as criterion? Or what about whether community has an active riverine group?
- Kyle: Our experience is that PREPA can be misleading because of question wording (e.g., Durham). Have had some communities question report, there have been disagreements.
- ?: May want to look at population density as it relates to the need for buffers and the ability to implement and enforce buffers.
- Michele: Add whether the watershed has a watershed association as part of the criteria.
- Duane: Community willingness could inadvertently bias results, you may want to pick subwatershed with most towns in it if you are worried about participation in general.
- ?: It would be interesting to see how towns with different demographic/economic characteristics impact willingness to implement.
- *David: We are looking at barriers, but if communities unwillingness is a barrier, we will be biasing. Lisa: we will look at how we can address capacity limitations.*
- Duane: The end user is us, but communities need to understand how this will benefit them. More of a messaging thing.
  - *Steve M: We've been struggling with this, why would communities want to participate?*

- Marcy: Want to emphasize the value of understanding those communities that can't or won't come to table, what the barriers are, what resources would get them over that hump, and how to create incentives.
- Jack: To the extent that there is a political barrier where you have to get past rifles and pitchforks, would be good to think about how to address that.
- *Jamie: If we narrow down communities, we want to verify those assumptions in PREPA.*
- Julie: If you do come up with a list of criteria it will be ranking a community relative to how rankings came out in others – subjective, not all criteria are equal. Also looking at where impaired waters are today could be important.
- Cat: Re: MS4 and non-MS4, is there a middle ground for communities, i.e. "not yet"? Maybe also look to those communities that might become MS4.
- Duane: Was one watershed RPC and SPC?
- Julie: Timeframe? *Winter/spring.* Coordination challenge.
- Julie: What do people get out of this?
    - *Cory: How should we redirect our resources so we can meet communities where they are with what they need?*
    - Julie: Communities as mentors—they can tell us how best they can actually help us (how best to spend money, etc.). Tell them expectations and potential benefits.
    - Jack: Who did you reach out to at town level? *Steve: Diverse.* Did you hear back more from cons coms or planning boards*? Cons coms*. Think about that.
    - Duane: I would be nervous if existing grants programs focused just on these communities. There may be other communities with valuable resources with respect to buffers that might lose out.
    - *Cory: Not either/or. Would not be refocusing everything, but maybe making a more strategic effort.*
    - *Jamie: The key is to go back to selection criteria, we want these subwatersheds to have components that are relevant to other places. Looking for commonalities in other places.*
    - *Cory: Goes to question about scale. Buffers are site specific, let's use that and leverage it, opportunity to do something and then spread it more broadly.*
    - Duane: If you are talking about making a measurable difference, your criteria don't reflect it.
    - *Cory: Pete's analysis will be incorporated so we understand opportunities related to preserving function, etc.*
- Michele: When you look at CWP's criteria for selecting a watershed, it's a small area. Look at the Lamprey – they have a lot of social infrastructure. But if they haven't done this by now, then I don't know how this is going to happen there. So part of me wants to look at a smaller watershed. Oyster/Bellamy or Winnicut, ideal size but they don't have the social infrastructure.
    - ?: Seems like GB communities are most at risk and have the most projects. There's a lot going on in these communities. Durham always seems to be tapped out. Maybe moving out to those communities that do not get most attention (maybe the yellow areas in Pete's map). We don't necessarily get out to the Lees, etc. Maybe one of each and compare results.
- Julie: Agree. Also important to understand commercial development potential. Winnicut. Don't see any issue with marrying this with our project of special merit (PSM). A lot of issues you brought up in mapping are relevant. Don't like one-size-fits-all buffer programs. You should look at things from a functional standpoint. That's one thing I'd like to support with our PSM.
- *Rachel: Prefer something like "Ecological function-driven buffers." Can't wait to see the rest of*

Pete's presentation. We can do a science-based approach that will matter to communities.

- *Mary Ann: I would echo comments about need versus capacity. DES wetland mitigation rules will come into effect February 1st and will require communities to have lists of mitigation opportunities, etc. or they will go into the General ARM Fund. If they have list, funds will be more likely to stay within that community; if they don't have the list, funds would go into general state fund. That would be a win win for a communities to understand how they can tie into those.*
- Duane: It would be helpful to know if the river serves as a drinking supply.
- Marcy: Variability on scientific end has to be matched on finance and investment end. Where will be the places where financial investment will be more likely because they (communities, investors) will see how it will have an impact with value.
    - Michele: We are doing a "what's our water worth" redo and ROI on buffers with respect to water quality and that would be valuable.
- Michele: ROI on buffers re: water quality; there are 3 Winnicut towns: Greenland, North Hampton, and Stratham; the "related groups/activities" column should be corrected to read NH Rivers Council Winnicut River Watershed Association and VRAP, NHRC Watershed Steward(TM) Program." The WRWC is a program of the NHRC. You may wish to standardize all local river management advisory committee names to the river(s) name and "LAC" (except for the Lamprey Advisory Committee), e.g., "Oyster River LAC." I would replace the "designated-limited activity" with "Cocheco River LAC" as they do exist, despite their recent dormancy (and has discussed merging with the Isinglass River LAC). There is also a Lamprey River Watershed Association and a different group that makes decisions on National Park Service funding.

Technical Review Panel, January – February 2016

- Limited value with observing community meetings and reviewing minutes. Spend more effort on the third task – the personal interviews with municipal officials and stakeholders.
- Linking an understanding between local perspectives with Bay-wide is critical but hard to get cohesive messages across these groups. For this knowledge database – identified as a final report currently – to be successful it needs to be well designed and maintained throughout the project.
- There could be a report back directly to the communities, especially the ones that were a focus of your interviews/focus groups.
- Develop an instrument (discussion guide) that can guide these interviews to ensure consistency across interviewers and interviewees, based on initial research and some preliminary interviews.
- Also investigate community planners' and decision makers' preferred formats for the end-product(s), what communication methods would best reach this audience.
- Give the focus group participants an understanding of how you plan to retain, build, and apply the information. You need a knowledge database product as part of or separate to the report.
- It might be helpful to compare a community outside of the Great Bay watershed to see if there are barriers, opportunities, etc., that are unique to the seacoast region vs. other NH locations.
- You need to be able to identify at least one person in each community that is very familiar with the local regulations and has experience with using them in real world applications (likely a municipal planner or a long serving Planning Board or Conservation Commission member).
- Be more product-oriented in this assessment so you illustrate you are in for the long haul with communities, creating a series of products that become the intellectual property of communities that evolves over time. Steer away from static products to dynamic ones where communities want them to evolve (e.g., online database, mapping tools, apps).
- In addition to the list of factors for choosing which watershed communities to work with, include

"history of flood damage." This may help indicate whether people perceive streams and buffers to be static or dynamic, what kinds of "ecosystem services" may be rendered from buffer protection, and the feasibility of establishing and maintaining buffers.

- It sounds as if you will be using the results of the policy analysis as input for some of your investigations. Your time frame may need to shift to accommodate the policy analysis.
- Need a clearly defined and designed DSS, and clearly articulated products (e.g., report, knowledge database, GIS database communication through an online decision support mapping tool).
- Try to ascertain where community planners are most accustomed to getting information.
- What perceptions do people have about enforcing buffer regulations at the community level? Setbacks may be considered during site plan review, but what about vegetation management? Do local zoning regulators feel they have the capacity to address this challenge?
- Include people who are not very actively involved or interested in these issues to have a representative view of their opinion as well.
- Include developers/consultants into the conversation since they work across communities/regions they may have a different perspective.

Response to Technical Review Panel, March 2016

1) ***Feedback reinforced an approach we already planned to take:***
    - Suggestion to develop a discussion guide for the "informal interviews" with colleagues. We do plan to do this, and "semi-structured" was probably a more suitable word than "informal."
    - Suggestion to identify at least one person in each community who is very familiar with the local regulations and has experience using them in real-world applications. This is an important step we anticipated doing but had not explicitly included in the plan as a "choice."
    - Suggestions to investigate where community planners/decision makers are getting information about natural resource planning and enforcement of buffer regulations. These are in line with the types of questions we will include in the community assessment.
    - Suggestion to include those who are not actively involved or interested in these issues to minimize skewing our results, e.g., developers and consultants. We have a consultant on the Advisory Committee and hope to invite a developer to join the Committee once the subwatershed selection is finalized. We have been discussing how to reach those not interested and will continue to think about our options for accomplishing this.

2) ***We will make a change based on this feedback:***
    - Suggestion to follow up with communities that participate in the interviews and focus groups. We had planned to follow up at the end of the project, but it may make sense to report back sooner (fall 2016) to share results of how each community's assessments and how they compare to the other communities. For communities interested in doing buffer-related work, this will lay the groundwork for going back to them after the project is complete.
    - Suggestion: add history of flood damage to community selection criteria. We will explore how we can incorporate that into the community selection process.

3) ***We may make a change based on this feedback:***
    - Suggestion that there may be limited value in observing community meetings and reviewing minutes. We may observe a few meetings to investigate their usefulness, but they are not likely to be major components of our data gathering efforts.
    - Suggestion that comparing our results to a community outside of the Great Bay watershed could

put the study into context. Following this advice is resource dependent. We plan to test our subwatershed-level results with other communities in the watershed. If we have additional time and capacity to test our results beyond the watershed, we will consider that.

4) Not currently planning to make a change based on this feedback:

- Suggestion to develop and maintain a "knowledge database" or "decision support system," rather than just a static final report. This interesting idea goes beyond the scope and resources of our projects.
- Suggestion to investigate stakeholders' preferred formats for end products. We plan to investigate stakeholder information needs, language-related barriers, and preferred sources of information. This information will inform the *content* of those products. However, given that the intended users of these products are those who support communities in making buffer-related decisions, we will tailor the formats for their needs.
- Suggestion that our timeline may need to shift to accommodate the policy analysis timing. We will use preliminary results—i.e. different options for buffer management—from the Policy Analysis work to accomplish our Community Assessment work at this time.

Project Team webinar, March 8, 2016

Jamie Houle, Tom Ballestero, Paul Stacey, Ellie Baker, Steve Miller, Rachel Stevens, Cory Riley, Pete Steckler, Michele Holt-Shannon, Lisa Graichen, Dolores Leonard

Purpose: Identify subwatershed(s) and begin discussion of criteria for community selection

Agenda

- Review of subwatershed selection process undertaken by Stakeholder Engagement team (Steve/Lisa)
- Overview of technical team subwatershed selection process (Pete)
- Identify subwatershed(s) that align with engagement and technical teams' criteria (all)
- General criteria for community selection (Steve/Lisa/Pete/Cory)
- Next steps (Steve/Lisa)

Action items

- Start to explore communities in the Exeter-Squamscott subwatershed; if they are saturated move on to Oyster/Bellamy or Lamprey.
- Pete will share info about coastal partners meeting for those interested in a presentation of additional maps (Send to Dolores to bundle into BOB update.)
- Engagement team will consult AC members already working with communities of interest.
- All: Send any info you have about concurrent or recent projects in Exeter-Squamscott subwatershed you think the community assessment team should keep in mind.
- Cory/Dolores will work with community assessment team on language to frame project and its intentions for communities.

Discussion of engagement team's criteria for subwatershed/community selection (Steve/Lisa)

Lisa reviewed process for developing criteria and applied it to their analysis. Lamprey and Exeter-Squamscott (E/S) subwatersheds rose to top, with the caveat that there are no non-MS4 communities in the E/S (just MS4 communities and communities with waivers). Asked group if including non-MS4 communities is critical for this analysis (i.e., eliminating E/S from consideration; alternatively, could move forward with E/S and include non-MS4 communities in the broader "testing" of the subwatershed results in the future). (See ppt and handout.)

- Clarified reasons for community assessment, i.e., understanding communities' values related to buffers, perspectives about different buffer management options, etc.
- Consensus that MS4 was not a deal breaker. Noted that MS4 is a stormwater permit and does not have bearing on buffer regulations, more about closed drainage systems in municipality, though it was noted that having a non-MS4 community would get at motivations such towns would have for advancing buffers.
- Some emphasized need to look at diversity of landscapes, e.g., areas with a lot of impervious cover and areas with less impervious cover.
- Point made that baseline assumptions from PREPA need to be validated in communities we assess (e.g., know that Durham's PREPA is not correct). Understood, but we were going with idea that using PREPA to select communities to study works because it is an apples to apples comparison (if it's wrong it's wrong in same way).
- Clarified we are talking about one subwatershed, but we will try to ground-truth what we do there with representative groups around the Great Bay watershed.
- Recommendation to look at communities with different types of government and might be good to include an agriculture-heavy town.

Overview of technical team subwatershed selection process (Pete)
Pete and David looked at three layers:

1) Buffer layer shows clusters of opportunities for protection, i.e. either not developed, restorable, etc. Buffer width varied according to water body classification.
2) Salt marsh migration – areas where marsh will persist and/or migrate under different SLR – Lots of potential in E/S, Oyster-Bellamy, and Winnicut.
3) 2015 Wildlife Action Plan update – Lamprey stands out.

- Emphasized lower watershed, one reason being that potential for some services like nutrient attenuation were greater there Also salt marsh migration potential is bigger there. For E/S subwatershed, thought that Exeter, Newfields, Stratham, and Newmarket would be a nice mix of built up and more rural/residential communities. For Oyster-Bellamy, thinking Durham and Madbury. For Winnicut: Greenland and Stratham.

Discussion:

- Noted that E/S has best overlap between engagement team and technical team criteria. Agreed to start with E/S but remain open to moving on if those communities are saturated/not interested in participating.
- Caution that there is a lot happening in the E/S and that communities may be over-committed. Lamprey has more flexibility and more to choose from. Either way important to be careful that we get our hands on existing info and don't ask the same questions.
- Community willingness seems to be overarching, if there's enough overlap between engagement team and technical team (E/S) let's go see if they are willing; if not, then we can dig in more on other options.
- Clarified next steps: This info will ground what we learn and share about options for buffer management. Nothing in it for the community for the short-term, but could set them up for work later. Process is evaluate town characteristics, conduct investigatory interviews, then focus groups—all aimed at getting at deeper understanding of community values relates to buffers. Community sanction important. Want to keep an eye on number of interviews—20 in each

community might be too much.

- Process for reaching out to communities could be two-step, i.e, are you interested in participating in the project, then this is specifically what we are looking for. Phone call/email combination. Want to be careful about the ask and how project is framed. Not about steering people to one option or another, it's about laying out the options and the values attached to them. Need a new positive frame for this. Dolores and Cory can help with that.
- Concern noted that people you want to hear from are ones who have issues with buffers but may be less inclined to participate. How to get over that hurdle? Towns will know who we should reach out to. Also could talk to consultants who have worked on both sides of the issue.
- The E/S towns the tech team put forward are on the bay – Pete clarified there are a lot of important upland opportunities in those communities, they have both tidal and freshwater areas as well. Engagement team wants to try to include a community further upstream as well, but Pete's note is helpful.

General criteria for community selection (Lisa)

Lisa reviewed additional information about communities within this watershed, e.g., characteristics like population density, percent value of commercial areas (i.e., how predominant/important are commercial areas in the community), income, impaired waters, drinking water supply, etc. Lisa will send it out if people want to dig in.

- No issues voiced with any of the particular towns.
- Point made that we also have to consider the watershed, e.g., impervious cover impact on buffers. Some of Pete's maps address that and people can attend meeting where he will present them again. He will let us know. Also can look at layers on NH Granit.
- Important to consider both areas that are developed, where protecting buffers would be especially important, in addition to those areas that are not as developed that have a lot of protection opportunities. Also important to think about communities where you would expect a lot of growth. Where can you get ahead of wave? Look at Census data and talk to RPC about communities that have huge growth projections (recent Granite State Futures project).
- Check in with AC members – may have knowledge about specific communities to help us choose.

Project Team meeting, July 13, 2016

Discussion re: Community Assessment

- Status: Interviews with 31 stakeholders so far; lots of interesting results to dig into; thinking about how to approach analysis/reporting (esp. re: protecting interviewees' confidentiality)
- Potential gaps: landowners, farmers/ag land owners; Jamie suggested taking stock of what we have so far and letting that guide any gaps we try to fill
    - Think about protection/restoration pieces of decision-making framework
- Feedback on reporting approach – what works, what doesn't, opportunities; emphasize challenges at local level
    - Are there characteristics/demographics that help or hinder implementation? E.g., in what kinds of communities do you find more comprehensive buffer regulations?
    - Find out how communities address buffers within their planning efforts (i.e., which boards/staff members are aware/involved?)
- Conversations are identifying lots of challenges/issues, but not always specific needs/solutions – may need creative brainstorming with PT to think about how to address issues for Action Plan

Breakout Discussion re: Community Assessment Case Study Idea

- Could do studies of the 4 focus towns, but also incorporate other relevant ones for relevant communities in the watershed
- Look at regulatory history, challenges, history of ordinance development, community context, decision-making process – especially the ZBA, any "champions" who may have been involved
- Could still be valuable to include case studies in instances when ordinances were rejected or there was pushback after an ordinance was passed – to illustrate stumbling blocks, etc.
- Could look at the interactions/relationships between municipal boards to examine their effectiveness/consistency in decision-making
- If addressing the view that buffers can be used as a means to manage growth/constrain development, should also articulate the fact that there are innovative design options that encourage flexibility of development (i.e. provide examples of towns that have strong buffer regulations that are still economically thriving, or look at site designs – initial design proposed, show influence of buffers, then show redesign and that project was still successful)
- Need to think about how to protect interviewees' confidentiality, communities' identity…

Analysis Approach meeting, July 26, 2016

Michele Holt-Shannon, Jamie Houle, John Coon, Lisa Graichen, Carrie Portrie

NEXT STEPS:

- Jamie share resources re: mixed methods grounded theory with Lisa and Michele
- Michele will check in on timeline for transcription (aiming to finish up the first week of August)
    - Lisa will make sure Michele has recordings for interviews conducted since initial file transfer
- Lisa work on pulling together community profiles (context for theming)
- Lisa/Steve will write a memo for each transcript (capturing "snippets" and any major impressions)
- Lisa will check in during August to schedule small group meeting in September for 1st cut at theming
    - Michele/Jamie – Think about design (e.g., who needs to be in the room) In the meantime
- Lisa/Steve work on outline/matrix that could include all info (e.g., ordinance assessment, other resources) in addition to the interview results (John's suggestion, Kerry's example)
- Lisa follow up with John re: preliminary results summary, Google Docs troubleshooting

TIMELINE:

Late July – Early August	• Develop community profiles for the four communities (Lisa/Steve) • Wrap up interviews (Lisa/Steve) • Complete transcribing (Michele's students)
August	• Develop memo for each interview (Lisa/Steve) • Lisa schedule September group meeting • All – think about design for group theming work in September
September	• Small group convene to start theming process (Michele, Jamie, John, Lisa, Steve, Cory Riley, David Patrick, Dolores Leonard; who else?
October 18	• Advisory Committee meeting

ARCHITECTURE:

1. **Community: Fremont / Chester / Exeter / Stratham**
    a. **Internal**
        i. *Professional:* code enforcement officers, town planners, town managers/administrators (n=12)
        ii. *Volunteer:* members of Conservation Commission, Planning Board, Zoning Board, Selectboard (n=10)
    b. **External**
        i. *Professional:* engineers, wetland scientists, developers, regional planners; i.e., work intersects with buffers/they work with communities in different capacities (n=13)

OTHER NOTES:

- Lisa/Steve doing a couple more interviews over next week or two, then pausing to focus on analysis
- Discussed potential to use Nvivo – doesn't seem like it will be needed for this (integrated assessment – not generating new data; not aiming to publish)
- How we set up the architecture/categories – depends how much we want to dig in/tease out; can start with more categories and lump/combine if appropriate
- A few instances of overlap (e.g., engineer who used to serve on town's planning board – both perspectives/experiences)
- Process: data (transcripts + notes) → coding
    - 1st step – re-read transcripts, ID key points, capture important quotes, write memo for each
        - At top of each memo, write categories the interviewee falls into (e.g., Fremont – Internal – Volunteer)
    - Then do the sticky note exercise (pulling out themes, "binning" into categories)
        - E.g., Michele creates bullet points → sticky notes on sheets of paper (printed memos) around the room; can combine key points from memos within categories, start to look for themes across categories; see if there are differences (may not be)
    - Potentially form a conceptual theory about buffer implementation in communities
- Talked about other potential categories for architecture – think we are going to look at the four communities separately first, then identify any differences worth investigating further
    - Other characteristics to track – municipal budget, level of development (maybe corresponds to population), how many town staff, proximity to Great Bay, upper/lower watershed communities, regulated/non-regulated (MS4)
        - Community profiles, contextual landscape
- Outline all the potential info we'll be pulling together in advance (interviews + anything else) – important to have an organized structure in advance
- Another consideration – protecting anonymity of interviewees
- Also can do more work in the late fall to "test" findings in other communities

Project Team and Advisory Committee survey feedback, October 2016

Respondents:

Abigail Lyon	Piscataqua Region Estuaries Partnership	(AC)
Cory Riley	Great Bay National Estuarine Research Reserve	(PT)
Dave Patrick	The Nature Conservancy	(PT)
Jay Diener	Hampton Conservation Commission	(AC)
John Coon	UNH	(AC)
Kalle Matso	Piscataqua Region Estuaries Partnership	(PT)
Kyle Pimental	Strafford Regional Planning Commission	(AC)
Laura Deming	NH Audubon	(AC)
Lisa Graichen	Great Bay National Estuarine Research Reserve	(PT)
Marcy Lyman	Bullard Fellow	(AC)
Michele L. Tremblay	New Hampshire Rivers Council	(AC)
Paul Stacey	Great Bay National Estuarine Research Reserve	(PT)
Steve Couture	NHDES Coastal Program	(PT)
Steve Miller	Great Bay National Estuarine Research Reserve	(PT)
Tin Smith	Wells National Estuarine Research Reserve	(AC)
Tom Ballestero	UNH Stormwater Center	(PT)

Anonymous (PT)
Anonymous x5 (AC)

Would you use the Community Assessment information in your work?

Yes: 12 *Maybe/unsure: 6* *No response: 4*

- I would use these findings to plan and prioritize outreach/education efforts to address communities' needs; also would use the inventory of municipalities' buffers to determine where to focus efforts related to NH Hampshire, understanding which communities are likely to be receptive to our engagement is of obvious importance. More broadly, successful environmental protection necessitates understanding stakeholder perspectives and framing information and outreach accordingly. The community assessment provides a valuable snapshot of perspectives towards buffers, that will help TNC in identifying the most effective ways to promote adoption of the use of buffers in the coastal watershed.
- To understand the perspectives, engage them, and to use this information in the design of future buffer outreach, education and policy.
- It suggests to me that better science needs to be applied, and a "one-size fits all" approach is viewed as "protective." Converged with science, we might be able to show HOW protective and guide local decisions towards a more quantitative assessment of level of protection so they can make better decisions of how protective they want to be. The decision can then be based on environmental benefits in the context of human health and welfare.
- Still seems vague and needs hard strategies and deadlines, as well as more site- and town-specific incentives and outcomes.
- To check/test our knowledge/assumptions/approaches.
- In theory this information would be very helpful, however we would need the information to be vetted at the local level to ensure accuracy.

- For restoration projects and for the Council's Watershed Steward™ Program.
- Not sure of its relevance to Maine communities.
- It will be helpful to understand the current community values of communities we are working in and their perceptions and misperceptions.
- Already have knowledge about the information in the Executive Summary.
- Helpful in understanding degree of understanding/awareness of science and application of science in decision-making, to understand what communities need in terms of information/training and support.
- Support for decisions on buffer management and protection.
- The buffer ordinance inventory is directly tied with the PREPA work at PREP and incorporating that data into the State of Our Estuaries report. Additional information about the community context will better inform technical assistance providers in promoting increased buffers in a particular community. No one size fits all for buffers, and it's important to connect with a community's values when attempting to increase natural resource protections. Having a list of the most up-to-date information (policy recommendations, science, etc.) is also helpful for municipalities who need to be able to draw on expertise when working to increase buffer protections.
- I don't work on this topic presently.

Would it be useful for you to have access to the compilation of Community Assessment resources?

Yes: 13 *Maybe/unsure: 4* *No response: 5*

- Google Drive is fine.
- Not sure what has been missed, I would want access to this, maybe as pdfs on a website as separate docs with a one sentence description?
- We have access to most of the items on this list already, but having a well-organized online repository for these resources is helpful.
- Concise summary with full report for reference.
- I like the organization. The last page and a half seemed more like lit review summary than a resource.
- They would be most useful if organized, summarized, digested and written up in a review document by experts for general consumption. The Policy Analysis interim report is a good example of how that should be done.
- The information is useful to me as a researcher. As far as its utility to organizations, I have no comment.
- It is always good to know about available resources that may be helpful in making recommendations in our community.
- I think the way that it is presented is fine. The list is broken down by spatial location (i.e. state, subwatershed) and if folks want more information they can easily use their Google machines to find the report or document. Two resources that may want to be added are the Oyster River Integrated Watershed Plan for Nitrogen Reductions (VHB) and the Salmon Falls Collaborative: Action Plan.
- Documents related to the Maine portions of the watersheds were missing.
- There are many hyperlinks to the resources, which is great, but I know there are more resources that are shown that are stored on the internet. For instance, the Land Conservation Plan for NH's

Coastal Watershed. It would also be helpful to have the resources searchable by keywords/topics. For instance, if you are looking for a resource that addresses agricultural buffers you could find them, or if you want to find information about climate change and buffers you could search for that.

- It's a good compilation; already have access to, use, and apply most of the resources listed.
- Website… maybe a page on the GB reserve site?
- Perhaps a website with drop down menus of the different subwatersheds to direct communities and technical assistance providers with the most relevant info. I'm wondering too, not having had a great deal of time to dive into the resources themselves, if it makes sense to have them organized by topic as well. Categories could include 'scientific reasoning for buffer widths', 'case studies', 'educational templates/examples', etc. Trying to think of a way for other communities to not have to reinvent the wheel in terms of outreach. See what has worked, and build upon those examples. I realize the audience for this project is not communities specifically, but having technical assistance providers with access to all of this information will help inform communities in their buffer projects.

Are there other resources that cover this type of information that you would typically use?
Yes: 6 *No: 8* *No response: 8*

- PREPA for some information about communities' ordinances, though we've been told (and have found) that there are some discrepancies.
- Not all in one place.
- Local needs assessments of municipal decision makers about buffer design, implementation, and enforcement.
- Maybe PREPA to some extent. It would be nice to have this supplement the PREPA.
- It's a pretty good list, but translation of science into law is always messy. It would be helpful to integrate how the biophysical structural-functional conditions is translated into the largely metaphysical outcomes of buffers regulation and management at the local level, and what the compromises are for both environment and society – a tough integration to make.
- We would typically do an internet search on whatever the subject is.
- Flood risk products from FEMA? These may include HAZUS reports (cost estimates for potential losses) and depth grids that detail flood depths for different flooding scenarios. I'm not sure if this is relevant or not.
- Resources from federal agencies (e.g. EPA, NOAA, NRCS, etc.).
- Not that I have seen in one central location. Often drawing upon the expertise of multiple people for any given project on buffers.

What mechanism would be most useful for reporting the interview findings?

A synthesis of all of our key findings	Individual summaries of findings broken out by topic area (e.g., summary of findings re: state-level policy)	Individual summaries of findings from the 4 focal communities	Individual summaries of findings from the different types of stakeholders	A compilation of relevant quotes from our interviews	Case studies
14	**13**	**7**	**8**	**4**	**7**

(6 did not respond)

- I would want the community-specific stuff to inform very specific projects we do with them in the future. Quotes are excellent fodder for grants to address their issues. Case studies provide context and help other communities understand how their challenges are like or not like other towns.
- I can see utility in all of these approaches. Case studies are always helpful, especially if success is achieved!
- All are useful, but in hopes of making changes for the better, key findings and individual summaries would be the most valuable agent of change. Never forget that existing community policy and management defines what's on the books and how they implement management; it does not give it any brand of effectiveness. That needs a fresh and continuing assessment.
- The ultimate goal is a Great Bay watershed with natural buffers. To achieve this, people need to see the real benefits and costs.
- Case studies: It is always helpful to see how various bodies in other towns handled similar situations.
- Perhaps some of the more detailed information could be included in an appendix? That way if folks wanted more information they could get it. Also, was there a reason the four communities were all in Rockingham? Was there any thought given to including a community from Strafford as part of the focal communities? Many consider themselves Great Bay communities.
- All of this information would be helpful. The case studies would be helpful for the Council's ongoing community-based social marketing work with its Watershed Steward™ Program. We like to see what incentives and social barrier removal tools are accepted and what are not accepted.
- List of people interviewed and in which capacity they responded.
- A synthesis of key findings by topic area would be most useful. The findings from the focal communities maybe be helpful for the part of the report that addresses the focal communities since the information is likely to provide good context. Helpful to use as “learn from experience” examples.
- Having a summary of findings broken out by topic area will be useful in knowledge transfer with other communities. Although only a few communities were interviewed, the lessons learned and struggles/barriers are often similar. Similarly it would be helpful to have the summary from different types of stakeholders, although that might be able to be wrapped into the different topic areas (i.e. barriers for Conservation Commissions, vs. barriers for engineers, etc.).

Is the draft inventory of municipalities’ buffers helpful? Can you envision using this information?

Yes: 11 *Maybe/unsure: 5* *No: 1* *No response: 4*

- Helpful to get a sense of which communities actually have buffers and which don't. Might help to have a brief, higher-level written summary – i.e., how many communities have no cut buffers, how many don't; any subwatershed-level summaries.
- I think we should all know this type of basic info walking into a project in a place- my only thing here is how will we keep it current (with PREP?) – filtering would be good.
- We don't have a specific use for this information right now, but it is really helpful to have a sense of the range of different approaches being used and commonalities. In the future, I could see us using this information in a number of ways: 1) to advocate for changes in state policy (for example, wetland rules) 2) to be able to point towards "progressive" communities as examples when working in the watershed.
- To understand the buffer landscape on the municipal level, in outreach and education to show what others are doing and why, and to target/recruit buffer leaders and those that may need help.
- How is this different than PREPA?
- I can see its value, and it is formatted in a way that would be useful to me.
- A graphical form would be much better, and then information about how this buffer happened (what was the mechanism) as well as demonstrable benefits.
- In making recommendations to various boards/departments in our town, it is always helpful to point out how what we propose compares to other similar towns.
- As I mentioned before, this is great – it just needed the stamp of approval from each community to ensure things are up-to-date and accurate.
- I think that communities being able to see where they stand with other municipalities is often the first step to raising the bar with local ordinances.
- Maine communities have not yet been included.
- I'd recommend the key on the right side of the first page repeat on later pages. We need to keep in mind that this is a snapshot in time and ordinances and regulations change. I'd recommend that the user be able to sort the information by community name too.
- The color-coded format does not translate to black/white printing. Suggest using symbols to denote different types of buffers.
- Love that you broke out wetland/shoreland. Would be helpful to indicate state standards as well. I would love to add who administers the buffer (e.g., ConCom, Planning/Zoning Boards).
- Yes, this is definitely something that PREP will/does use with the PREPA report. What about different buffer widths for different bodies of water (e.g. fourth order streams, 2nd order streams, lakes, ponds, etc.) as these can vary within a municipality. It would be helpful to see which communities are meeting or exceeding the recommended distances for buffers from NHDES. Highlight where work needs to be done. Where is this going to live also once created? PREP has been discussing incorporating buffer/setback data into SOOE and working to keep it updated. Worried about having this information live in multiple locations.
- What are examples of certain buffer widths, conditions? Examples of where the buffer works well, and where there are challenges.

Do you have any suggestions for integrating the Community Assessment findings with other components of the project?

- We've been talking with Cat and Trevor about the Regional Resilience Project, and the idea of visually 'mapping' the policy/decision-making framework – i.e., which stakeholders are involved and how, and what laws/policies are involved. Might be helpful to consider some sort of visualization for the community assessment + policy findings.
- Looks like link to variable width science, linking some community perspectives to policy analysis and statewide regulations, want to make sure capacity gaps and training needs are part of action plan, curious if the economic benefits could be summarized in Dana's work.
- I believe it is central to all the other components, and that all components should use the CA findings in their recommendations/findings.
- Linking to state level policy is important!
- I think that's what this project is about – as I noted above, how do we turn the curve on improving buffers management and value for both the environment and community health and welfare? Without the context of good science and socioeconomic analysis, rules are simply rules with no quantifiable outcome. They will certainly vary in outcomes depending on many biophysical and application factors. I do cringe when I see that this or that rule "protects" buffers – very misleading.
- Linking these to the more global system and the value of each in achieving the long-range goal.
- Outreach and engagement?
- The conservation community, especially land trusts, need to be included (perhaps they are) as they are both advocates for buffers but also provide permanent protection.
- When discussing the focal communities, the Community Assessment findings should be integrated as helping to set the stage of the individual communities.
- It would be useful to have a summary of findings for each community that includes a report of what they do or do not have for regulatory buffers and other water resources protections. Compare their attitudes and practices to how they do/do not implement protection measures.

Additional feedback sent by Marcy Lyman – **Community assessment:** I would add and emphasize in the Community Assessment the role of outreach to landowners, municipal decision-makers to advance knowledge, awareness and application of knowledge of science of buffers and different strategies for conservation/management. That would reinforce the finding in the Policy Executive Summary that DES wants more outreach tools around buffers.

Advisory Committee meeting, October 18, 2016

Participants:

Project Team	Advisory Committee
Cory Riley, *Great Bay NERR*	Cat Ashcraft, *UNH*
Dana Bauer, *Clark University*	John Coon, *UNH/consultant*
Dolores Leonard, *Roca Communications*	Tracy Degnan, *USDA NRCS RCCD*
Jamie Houle, *UNH Stormwater Center*	Laura Deming, *NH Audubon*
Kalle Matso, *PREP*	Jay Diener, *Hampton Conservation Commission*
Lisa Graichen, *Great Bay BNERR*	Duane Hyde, *Southeast Land Trust of NH*
Paul Stacey, *Great Bay BNERR*	Marc Jacobs, *wetland scientist*
Pete Steckler, *TNC*	Julie LaBranche, *Rockingham RPC*
Rachel Stevens, *Great Bay NERR*	Ruth Ladd, *Army Corps of Engineers*
Simone Barley-Greenfield, *NHDES/PREP*	Marcy West Lyman, *Fellow at Harvard Forest*
Steve Couture, *NHDES*	Julia Peterson, *NH Sea Grant/UNH Cooperative Extension*
Steve Miller, *Great Bay NERR*	Tin Smith, *Wells NERR*
Shea Flanagan, *TNC*	Abigail Gronberg-Lyon, *PREP*
	Dave Sharples, *Town of Exeter*
	Aaron Hume, *Town of Chester*

Community Assessment Roundtable:

- **Analysis categories** [see handout]
  - Clarify what 'regulatory short-circuit' category means
  - 'Water resources' appears on community side but not external?
  - Decision-making process and enforcement = very important

- **How to present information?**
  - Try to tell a cohesive story
  - Tie back to different values and functions of buffers
  - Highlight key tensions (e.g., enforcement – capacity), give relevant examples/quotes
  - Example of what worked and what did not work (successes/failures)
  - Quotes, website (key categories with rotating quotes)
  - ID the issues that come up frequently, but also the outliers
  - Synthesizing key themes more useful than quotes
  - Case studies – use example of proactive town and how they made it happen
    - Examples: Hampton Falls (relaxed buffer because "too many variances"); Exeter (engaged citizens group)
    - Key content = end result – start with that, then outline process that got them there
  - Think about benefits of buffers – economics, quality of life, water quality, municipal solvency (tax base), health and safety, etc. → need to treat buffers as assets

- **Gaps to fill/directions to pursue in Year 2**
  - Are the findings applicable to the rest of the watershed?
  - Property owners – randomly pick via tax records; select a range (e.g., <5 acres, 100+ acres); ID shoreland property owners through online GIS (e.g., Newington)
  - Tax assessors? Look into/clarify tax benefit situation – e.g., "Loss of value" on property –

claim it as a donation on taxes?
- Issues of aggregation (single parcel / cumulative effects)
- How do you incentivize it?
- State reg?
- Maybe further explore non-regulatory options, sounds like interviewees weren't clear on/aware of non-regulatory options; what are the carrots vs. sticks (overlap with policy)
  - Esp. land conservation options – maybe talk with conservation organization reps
    - E.g., holding buffer easements, esp. on small parcels – difficult for conservation organization; how to foster more aggregated approach (e.g., lake association – get everyone to agree to do it...)
  - Current use? Minimum size issues (can we make CU apply to smaller size lots)
- More on property values – e.g., connection to water quality/clarity
- Demographic information, growth pressures → connect to interview findings
- Connections between perspectives toward growth/development and the interview findings?
- What's the infrastructure for technical assistance in the state?

- **Community Assessment-related Action Plan ideas**
  - Average citizens – need community education, communication
    - # of voters = indicator of community involvement
    - Issue perceived as very complex, technical
    - Dealing with turnover, burnout, difficulty getting volunteers, bedroom community
  - Education at different levels/to different audiences – To get ordinance passed, who do you have to educate? Everyone, or just focus on certain segments of the population?
  - Address comfort level with info about buffers and with experts in front of them?
  - Mitigation? Very complex for community boards to be determining; need technical assistance on mitigation (ARM, etc.)
  - How can we integrate with maps and policy analysis? Build a community resource that guides them through the process.
  - How to start treating buffers as town assets – all should contribute
  - ID mitigation parameters – % of services, ratio – seems risky to entrust that to municipal volunteers; maybe some training opportunities there?

- **Other notes/thoughts**
  - Upper watershed town – more rural, less strict regs; lower watershed town – stronger reg, but more built up; buffer table – look at any connections between interview results
    - Also, SWQPA disproportionately geared toward 3rd/4th (lower watershed)
  - Buffers affect developed vs. undeveloped properties differently
  - Community side – no one wants to be the enforcer (discomfort, affects relationships)
  - Pressure on towns (e.g., recession → pressure to relax regs)
  - See Molly's survey – Strafford
  - Jay will send Lisa updates on Hampton re: buffer inventory

Community Assessment Component Response to Feedback (November 2016)

CATEGORY	FEEDBACK	FROM (if relevant)	COMPONENT RESPONSE	OTHER NOTES
ANALYSIS/REPORTING	Need hard strategies/deadlines and more site- or town-specific incentives and outcomes	Survey	ACTION PLAN	Developing town-specific strategies is probably beyond the scope of the interim report, but will capture in Action Plan
ANALYSIS/REPORTING	Analysis categories - clarify what 'regulatory short-circuit' category means	AC meeting 2	INTERIM REPORT	
ANALYSIS/REPORTING	Water resources appears on community side but not external? (analysis categories)	AC meeting 2	INTERIM REPORT	
ANALYSIS/REPORTING	Tie findings back to different values and functions of buffers	AC meeting 2	INTERIM REPORT	
ANALYSIS/REPORTING	Highlight key tensions (e.g., enforcement - capacity), give relevant examples/quotes	AC meeting 2	INTERIM REPORT	
ANALYSIS/REPORTING	Example of what worked and what did not work (successes/failures)	AC meeting 2	INTERIM REPORT	
ANALYSIS/REPORTING	ID issues that come up frequently, but also outliers	AC meeting 2	INTERIM REPORT	
ANALYSIS/REPORTING	Synthesizing key themes is more useful than quotes	AC meeting 2	INTERIM REPORT	
ANALYSIS/REPORTING	Demographic information, growth pressures --> connect to interview findings	AC meeting 2	INTERIM REPORT	
ANALYSIS/REPORTING	Connections between perspectives toward growth/development and the interview findings?	AC meeting 2	INTERIM REPORT	
ANALYSIS/REPORTING	Upper watershed town - more rural, less strict regs; lower watershed town - stronger reg, more built up; buffer table - look at connections to interview results?	AC meeting 2	INTERIM REPORT	
ANALYSIS/REPORTING	Pressure on towns (e.g., recession --> pressure to relax regs)	AC meeting 2	INTERIM REPORT	
ANALYSIS/REPORTING	See Molly's survey - Strafford	AC meeting 2	INTERIM REPORT	
ANALYSIS/REPORTING	Preferences for reporting interview findings - 1) synthesis of all of our key findings, 2) individual summaries of findings broken out by topic area, 3) individual summaries of findings from the different types of stakeholders, 4) case studies (tied), 4) individual summaries of findings from the 4 focal communities, 5) compilation of relevant quotes from our interviews	Survey	INTERIM REPORT	
ANALYSIS/REPORTING	Include more detailed information as an appendix	Survey	INTERIM REPORT	
ANALYSIS/REPORTING	List of people interviewed	Survey	INTERIM REPORT	*Will include a list of the types of people we interviewed but not their names
ANALYSIS/REPORTING	Quotes, website (key categories with rotating quotes)	AC meeting 2	UNSURE	Depends on format of final products; can consider including quotes on website/report, but may not be rotating

Community Assessment Component Response to Feedback (November 2016)

CATEGORY	FEEDBACK	FROM (if relevant)	COMPONENT RESPONSE	OTHER NOTES
ANALYSIS/REPORTING	Have a summary of findings for each community that includes a report of what they do or do not have for regulatory buffers and other water resources protections. Compare their attitudes and practices to how they do/do not implement protection measures.	Survey	INTERIM REPORT	Will try to achieve this as much as we can in the interim report
ANALYSIS/REPORTING	Emphasize in the CA the role of outreach to landowners, municipal decision-makers to advance knowledge, awareness, and application of knowledge of science of buffers and different strategies for conservation/management.	Marcy Lyman email	ACTION PLAN	
BUFFER INVENTORY	How to keep it current	Survey	ACTION PLAN	
BUFFER INVENTORY	How is this different from PREPA?	Survey	CLARIFICATION	Focuses on vegetated buffers, based on a review of communities' ordinances, rather than a survey; provides more detail; attempts to address some of the discrepancies noted in PREPA
BUFFER INVENTORY	Higher level written summary	Survey	INTERIM REPORT	
BUFFER INVENTORY	Filtering option (e.g., sorting by community name)	Survey	INTERIM REPORT	
BUFFER INVENTORY	Need stamp of approval from communities - make sure it's up-to-date and accurate	Survey	INTERIM REPORT	
BUFFER INVENTORY	Include Maine communities	Survey	INTERIM REPORT	
BUFFER INVENTORY	Repeat the key on each page	Survey	INTERIM REPORT	
BUFFER INVENTORY	Keep in mind this is a snapshot in time, regulations change	Survey	INTERIM REPORT / ACTION PLAN	
BUFFER INVENTORY	Case studies - use example of proactive town and how they made it happen; key content = end result + outline process that got them there	AC meeting 2	INTERIM REPORT?	Will consider this approach for reporting our findings
BUFFER INVENTORY	Graphical form would be better	Survey	UNSURE	Not sure how to make a graphical form of this because of the level of detail, hard to distill to a graph
BUFFER INVENTORY	Information about how the buffer happened (what was the mechanism) and demonstrable benefits	Survey	INTERIM REPORT?	Probably beyond the scope
BUFFER INVENTORY	Indicate state standards too	Survey	INTERIM REPORT	
BUFFER INVENTORY	Add who administers the buffer (e.g., CC, Planning Board, Zoning Board)	Survey	UNSURE	This information isn't always provided in the ordinance, and may not be the same as what happens on the ground.
BUFFER INVENTORY	Show different buffer widths for different bodies of water	Survey	UNSURE	

Community Assessment Component Response to Feedback (November 2016)

CATEGORY	FEEDBACK	FROM (if relevant)	COMPONENT RESPONSE	OTHER NOTES
BUFFER INVENTORY	Show which communities are meeting or exceeding the recommended distances for buffers from NHDES, highlight where work needs to be done	Survey	INTERIM REPORT	Good suggestion
BUFFER INVENTORY	Where is this going to live? Worried about having this information live in multiple locations.	Survey	UNSURE	Think this will be more of an internal document for the organizations involved in the project, but can discuss potential issues, overlap with PREPA/SOOE, etc.
BUFFER INVENTORY	Examples of where the buffer works well and where are the challenges	Survey	INTERIM REPORT?	I think we can summarize some examples from our interviews and resource review, etc.
ENFORCEMENT	Community side - no one wants to be the enforcer (discomfort, affects relationships)	AC meeting 2	INTERIM REPORT / ACTION PLAN	
GAPS	Are the findings applicable to the rest of the watershed?	AC meeting 2	BOB YEAR 2?	
GAPS	Talk to property owners	AC meeting 2	BOB YEAR 2?	
GAPS	Talk to tax assessors? Clarify the tax benefit situation (e.g., "loss of value" on property can be claimed as a donation on taxes?)	AC meeting 2	BOB YEAR 2?	
GAPS	Talk with conservation organizations/land trusts	AC meeting 2	BOB YEAR 2?	
GAPS	Need to vet the info at the local level to ensure accuracy	Survey	BOB YEAR 2?	
GAPS	Strafford communities	Survey	BOB YEAR 2?	
GAPS	How to incentive buffers?	AC meeting 2	INTEGRATION	POLICY
GAPS	State reg?	AC meeting 2	INTEGRATION	POLICY
GAPS	Maybe further explore non-regulatory options	AC meeting 2	INTEGRATION	POLICY
GAPS	Look at issues with current use	AC meeting 2	INTEGRATION	POLICY
GAPS	More on property values - connection to water quality/clarity	AC meeting 2	INTEGRATION	ECONOMICS, TECHNICAL
INTEGRATION	Include capacity gaps and training needs in Action Plan	Survey	ACTION PLAN	
INTEGRATION	Include the conservation community, especially land trusts - advocates for buffers, provide permanent protection	Survey	BOB YEAR 2?	
INTEGRATION	Link to variable width science	Survey	INTEGRATION	We can compile our findings about perspectives about variable buffers, then see if there is science from the lit review to support this approach
INTEGRATION	Link to economic benefits from Dana's work	Survey	INTEGRATION	We will work with Dana to see what her work can address related to the CA findings

Community Assessment Component Response to Feedback (November 2016)

CATEGORY	FEEDBACK	FROM (if relevant)	COMPONENT RESPONSE	OTHER NOTES
INTEGRATION	Link community perspectives to policy analysis and statewide regulations	Survey	INTEGRATION	
INTEGRATION	All other project components should use CA findings in their recommendations	Survey	INTEGRATION	
INTEGRATION	Saying a rule "protects" buffers is misleading	Survey	INTEGRATION	Will keep in mind for communication/language in products
INTEGRATION	Integrate how biophysical structural-functional conditions are translated into metaphysical outcomes of buffer reg/mgmt. at local level, what the compromises are for the environment and society	Survey	INTEGRATION	
INTEGRATION	Think about benefits of buffers - economics, quality of life, water quality, municipal solvency, health and safety --> need to treat buffers as assets	AC meeting 2	INTEGRATION / ACTION PLAN	
INTEGRATION	How can we integrate with maps and policy analysis? Build a community resource that guides them through the process	AC meeting 2	INTEGRATION / ACTION PLAN	
INTEGRATION	Visually 'map' the policy/decision-making framework	Survey	INTERIM REPORT?	Will explore potential options/need
OTHER	Include capacity gaps and training needs in Action Plan	Survey	ACTION PLAN	
OTHER	Issues of aggregation (single parcel/cumulative effects)	AC meeting 2	ACTION PLAN	
OTHER	Average citizens need community education, communication	AC meeting 2	ACTION PLAN	
OTHER	# of voters = indicator of community involvement	AC meeting 2	ACTION PLAN	
OTHER	Dealing with turnover, burnout, difficulty getting volunteers, bedroom community	AC meeting 2	ACTION PLAN	
OTHER	Education at different levels/to different audiences - to get ordinance passed, who do you have to educate? Everyone, or just focus on certain segments of the population?	AC meeting 2	ACTION PLAN	
OTHER	Address comfort level with information about buffers and with experts in front of them	AC meeting 2	ACTION PLAN	
OTHER	Mitigation? Very complex for community boards to be determining; need technical assistance on mitigation (ARM, etc.)	AC meeting 2	ACTION PLAN	
OTHER	How to start treating buffers as town assets - all should contribute	AC meeting 2	ACTION PLAN	
OTHER	ID mitigation parameters - % of services, ratio - seems risky to entrust that to municipal volunteers; maybe some training opportunities there?	AC meeting 2	ACTION PLAN	
OTHER	Buffer SWOT team to support communities	AC meeting 2	ACTION PLAN	
OTHER	Target audiences - provide funding to help audiences go through the process of considering buffer options, identifying actions, etc.	AC meeting 2	ACTION PLAN	
OTHER	Education and outreach to watershed groups	AC meeting 2	ACTION PLAN	

Community Assessment Component Response to Feedback (November 2016)

CATEGORY	FEEDBACK	FROM (if relevant)	COMPONENT RESPONSE	OTHER NOTES
OTHER	Support communities on legal issues	AC meeting 2	ACTION PLAN	
RESOURCE LIST	Two resources you may want to add: Oyster River Integrated Watershed Plan for Nitrogen Reductions (VHB) and the Salmon Falls Collaborative Action Plan	Survey	INTERIM REPORT	
RESOURCE LIST	Documents related to the Maine portions of the watersheds were missing	Survey	INTERIM REPORT	
RESOURCE LIST	There are many hyperlinks to the resources, which is great, but I know more of resources shown are available online (e.g., Land Conservation Plan for NH's Coastal Watershed)	Survey	INTERIM REPORT	
RESOURCE LIST	It would be helpful to have the resources searchable by keywords/topics. For instance, if you are looking for a resource that addresses agricultural buffers you could find them, or if you want to find information about climate change and buffers you could search for that	Survey	INTERIM REPORT?	Will try to accomplish this depending on capacity
RESOURCE LIST	Flood risk products from FEMA? These may include HAZUS reports (cost estimates for potential losses) and depth grids that detail flood depths for different flooding scenarios	Survey	INTERIM REPORT?	Will explore relevance and if useful, will add to resource list
RESOURCE LIST	Maybe as PDFs on a website as separate docs with a one-sentence description	Survey	UNSURE	If final product is a website, can explore options for compiling PDFs
RESOURCE LIST	Concise summary with full report for reference	Survey	UNSURE	Unsure of the degree to which we'll be able to do an in-depth report of all of the resources, but depending on capacity and need/usefulness we'll summarize what we can
RESOURCE LIST	Organized, summarized, digested, and written up in a review document by experts for general consumption, e.g., policy analysis interim report	Survey	UNSURE	Unsure of the degree to which we'll be able to summarize/synthesize all of the resources like the policy analysis, but depending on capacity and need/usefulness we'll do what we can
RESOURCE LIST	Website - maybe a page on the GB Reserve site?	Survey	ACTION PLAN	
RESOURCE LIST	Perhaps a website with drop down menus of the different subwatersheds to direct communities and technical assistance providers with the most relevant info.	Survey	ACTION PLAN	
RESOURCE LIST	Would it make sense to have the resources organized by topic as well? Categories could include 'scientific reasoning for buffer widths', 'case studies', 'educational templates/examples', etc.	Survey	INTERIM REPORT?	Can try to do a topical organization as well
RESOURCE LIST	Other resources from federal agencies (EPA, NOAA, NRCS, etc.)	Survey	INTERIM REPORT	Will try to incorporate some of these resources as well.

Community Assessment Component Response to Feedback (November 2016)

CATEGORY	FEEDBACK	FROM (if relevant)	COMPONENT RESPONSE	OTHER NOTES
OTHER	Don't forget that policy does not guarantee effectiveness	Survey	INTEGRATION / ACTION PLAN	Agreed; can highlight some of the challenges with enforcement and implementation from the interviews and identify some action plan items related to this; policy team may be looking into policy effectiveness
OTHER	People need to see the real benefits and costs	Survey	INTEGRATION / ACTION PLAN	Agreed; hoping the economic analysis can start giving us some of this information
OTHER	What's the infrastructure for technical assistance in the state?	AC meeting 2	INTERIM REPORT? / ACTION PLAN	Not sure how much of this we'll capture in the interim report, but can note in Action Plan at least
OTHER	SWQPA disproportionately geared toward 3rd/4th (lower watershed)	AC meeting 2	INTERIM REPORT? / INTEGRATION?	Will keep in mind for the interim report; may be relevant to other components as well - keep in mind during integration work as well
OTHER	Buffers affect developed vs. undeveloped properties differently	AC meeting 2	INTERIM REPORT? / INTEGRATION?	Will keep in mind for interim report and integration
OTHER	Trying to think of a way for other communities to not have to reinvent the wheel in terms of outreach. See what has worked, and build upon those examples. I realize the audience for this project is not communities specifically, but having technical assistance providers with access to all of this information will help inform communities in their buffer projects.	Survey	ACTION PLAN	

Community Assessment Technical Review 2: Feedback and Response

Handling Technical Review Feedback: Cory's recommended approach

1. **Make sure the report is credible:** If the review came back and indicated that the report was "credible," all changes are optional. If the review indicated that the credibility was mixed or it was not credible, get in touch with the reviewer to see what changes are critical to get to credible.
2. **Consider which recommendations to address in your report:** When conducting this step, please keep the following criteria in mind:
    a. Is the recommendation consistent with something we have already agreed is a high priority for us to address in year 2? See this document for the results of the last advisory committee. If the technical review repeats a priority, we should address it.
    b. Is the recommendation a fairly straightforward edit or change that makes sense to you

and is relatively easy to do? If yes, go ahead and make that change.

c. Is the recommendation a great idea that would require additional work or analysis that we were not planning on doing in year 2? If yes, please add it to the action plan.

d. Dolores and I had these criteria in mind as we read through the technical reviews, and then we discussed each recommendation and "coded/highlighted" each idea in one of three colors. You can see what it looks like here. Green indicated that we would address the comment because it was consistent with criteria a or b above, yellow indicated we wanted feedback from some of our policy partners so will require additional discussion (we scheduled that meeting for this week with Simone and Steve Couture), and red meant that we did not feel the need to address that comment as it did not meet the criteria above.

3. **Make sure to set up a meeting to get feedback right away if you are not sure what to do with a comment.**
4. **Make sure you add potential Action Items to the action plan.**

Steve Miller worked through all the reviews - his comments are in **Blue Bold,** using Cory's same color pattern (described above) for what to do with a comment. Any and all changes were then made to the Community Assessment document and posted on Google Drive. The only change to the document was to shift Sections V and VI to the Appendices.

Responses from Reviewer #1

- **Document name: BOB_community assessment_lit review-TNC-zf.doc**
- **File path:** GBNERR/BOB PROJECT/BOB Project Shared Drive/Technical review panel/Panel reviews 2017
- **Link:** https://docs.google.com/document/d/1J7TZkuxgeV91SlzsSygBjxQVh21VaDEOSWEasLuh8qA/edit?usp=sharing

1. Please choose your level of agreement with the following statement: "The analysis is sufficiently credible (i.e., meets standards for technical adequacy) to support decision-making around riparian buffer management in the Great Bay Estuary Watershed." To indicate your level of agreement, please bold or underline one of the following choices:

Community Assessment

Strongly agree
Agree – so for us all changes to the document are optional.
Mixed
Disagree
Strongly Disagree

Literature Review

Strongly agree
Agree
Mixed
Disagree

Strongly Disagree

2. Please comment qualitatively on the credibility of the analysis. Please highlight key strengths and weaknesses. Please make suggestions on key citations, methods, case studies that, if included, would strengthen the analysis.

Community Assessment
With such a strong Delphic approach to interviewing and illustrating the diversity of types of planners and geographies, I expected to see a stat on men versus women interviewed, and also ethnicity. Diversity is key to environmental viewpoints, reinforced by the interview questions (i.e. viewpoints on policy, types of clients). No change needed to the document.

I really liked the differentiation between internal and external remarks. That is an important delineation. Excellent.

The overarching themes could be conveyed better than a bullet outline**. I believe this has been addressed with the addition of the section that Christos T. added to the document.** I would encourage either shortening sentences, bolding specific parts of a sentence, or even create a table first of categories and "terms," that describe the themes, then have the narrative bullets below. Being succinct and making the themes pop in report is key to readings capturing the high-level messages. I would repeat this format for challenges & barriers. Policy options is closer to what I had in mind of being succinct. Also, highly encourage an executive summary in this regard – highlighting the top themes, challenges, barriers and policy options. What key messages do you want someone to walk away with if they have limited time but are interested? You've captured the reader who want to dive in, but not the reader who wants the high-level overview. This also applied to needs and opportunities. **A huge amount of time went into categorizing and shortening sentences. At this point there is no time to continue on this process. As this report is for the Project Team, readability/conciseness is not as important at this point. I will add this to the Action Plan as a concise two pager on the CA will be valuable to several Actions Items once the project is complete.**

In section VI consider a couple short paragraphs, again high-level, that describe the most important points about recommendations. Do this before the bulleted list. A list like this is usually for a project team, but not a wider audience, so better to give folks "the most important answers" first. **This will be added to the action plan**.

Sections V and VI seem more like Appendices to me. **This change will be made to the document**.

Responses from Reviewer #2

- **Document name: BOB: combined_policy_analysis__community_assessment_MK_tech_review**
- **File path:** GBNERR/BOB PROJECT/BOB Project Shared Drive/Technical review panel/Panel reviews 2017
- **Link:** https://docs.google.com/document/d/1I2q9am-T-E01-_dStREycqPzsdtomo-3cmufIERdXQs/edit?usp=sharing

1. Please choose your level of agreement with the following statement: "The analysis is sufficiently *credible (i.e., meets standards for technical adequacy) to support decision-making around riparian buffer management in the Great Bay Estuary Watershed." To indicate your level of agreement, please bold or underline one of the following choices:*

Strongly agree
Agree – so again for us all changes to the document are optional.
Mixed
Disagree
Strongly Disagree

2. Please comment qualitatively on the credibility of the analysis. Please highlight key strengths and weaknesses. Please make suggestions on key citations, methods, case studies that, if included, would strengthen the analysis.

Mike Kline review of the Policy Synthesis and Community Assessment Reports:
The report is organized by regulatory and non-regulatory approaches and case studies. I have found that a useful outline for analyzing actions or the incentives for action would be:

Regulatory
Technical Assistance
Funding Assistance
Education/Outreach

This outline is worth considering, since many if not all the non-regulatory approaches fit within these categories and many of the findings / recommendations coming out of the Community Assessment Report may be readily described under these categories. Different jurisdictional levels (fed/state/muni) have varying programs that offer these services and incentives. An interesting question is: what is the appropriate focus of each jurisdictional level? (Might be good to have a chart that shows jurisdiction.)

The policy report seems to lump together buffer policies for wetlands, lake shorelands, and riverine systems. They all have dynamic processes, and buffers play an important role in these processes, but rivers, streams, and their associated floodplains, are particularly dynamic due to their existence in higher gradient valley settings (i.e., they have slope). While the preponderance of buffer literature examines the role of vegetative buffer widths on the moderation of overland flows and surface roughness (in addition to WQ and habitat benefits), it only touches lightly on the role buffers play in stream energetics (equilibrium-based processes). The evolution of riparian buffer management has largely been silent on this buffer function, and, from my experience, this serious scientific oversight is borne out of 200+ years of stream channelization and the perception that streams (like their wetland and lake counterparts) are static systems. Similarly, buffer protection has become synonymous with vegetation management and therefore we miss the important linkage between stream, riparian, and floodplain (equilibrium) functions.

My recommendation is that the policy synthesis should acknowledge the growing awareness of the role of buffers in achieving the dynamic stream equilibrium conditions that we now know to be critical for public safety, water quality, and aquatic ecosystem integrity. Once we make this acknowledgement, stream buffers can (and should) be described as having of two separate but overlapping components: the "development setback" and a "naturally vegetated zone." I have written several papers that described the importance of this distinction, but, in summary, the setback not only provides for the vegetated zone but avoid encroachments (investments) that bring about deleterious stream channel management.

Ill-considered buffer management has also been a driver of stream channelization. I have seen people identify the requirements for buffer vegetation maintenance as the reason they seek public assistance to hard armor a stream. I have seen natural resource agencies use public funds, appropriated for water quality improvement, to "stabilize" a historically straightened stream for the purpose of protecting a buffer they just planted.

I recommend that the policy synthesis recognize that buffers for wetlands, lakeshores, and streams provide different functions, which should differentiate our management, and very likely changes the way local communities perceive regulation at the state and municipal levels.

The Community Assessment did not consider setbacks. In Vermont the linkage of buffer setbacks to public safety, property protection, economic resiliency, and lower liabilities has begun to turn around many of the local protestations heard when buffers are promoted solely for their natural values. Once a community decides that setbacks are in their best interests, the conversation over protecting a vegetative zone becomes much easier.

Besides making note of the above argument, I have no recommendations for enhancing the community assessment report. It's good data and paints an accurate picture of what practitioners have heard in local communities since buffer protection has become a thing. It provides a good foundation for the recommendation that the state needs to exert jurisdiction if buffer protection is really going to happen.

My last offerings relate to the Vermont Case Study. On Page 30 it states that the River Corridor Protection Area is comprised of a meander belt component and a riparian buffer component. This should read that the River Corridor is comprised of a meander belt…………… In the few places that refer to the term "River Corridor Protection Area" it should be just "River Corridor."

The Vermont Clean Water Initiative is described but it should be noted in this paragraph that this fund is used for River Corridor Easements and buffer restoration work and factors prominently as a state funding incentive for riparian management. One of the greatest incentives Vermont has created is the increased state cost share from the state Emergency Relief and Assistance Fund (ERAF) to help communities recover from flood disasters, if they've adopted river corridor protection (see attached Act 110 report).

Lastly, on page 31 of the Policy Synthesis, under the title of "Municipal Land Use Regulation," there is a description of the Vermont statutes requiring municipalities to send floodplain development and river corridor development proposals to the state (my Program) for technical review and to see if it complies with local regulations. This is huge. The lack of technical capacity at the local level is mentioned over and over again in the Community Assessment Report. In Vermont this technical assistance is one way to overcome this deficiency and maintain some local control. Last year we reviewed over 800 local projects and sent back, not only an evaluation of regulatory compliance, but feedback on how and why the town should protect their floodplain assets. This is a big commitment, but an increasingly effective approach to protecting dynamic streams, floodplains, and riparian buffers. **This will be added to the action plan.**

Summary of Interviewee Feedback on Draft Community Assessment Report

The following is the initial email sent by Steve Miller on 1/24/17 to all the people interviewed for the Community Assessment:

> Good afternoon,
>
> I am very pleased to be sending you the Draft *Buffer Options for the Bay Community Assessment*. As you recall Lisa and I promised to run this by everyone who agreed to be part of the Community Assessment and to be "interviewed" by us about buffers. The conversations we had were extremely rich with information and it took a lot longer to transcribe, compile, and categorize the perspectives we heard. I believe the extra time taken to be thoughtful and fair to the information was well worth it.
>
> Great care was taken to accurately represent all we heard as well as keep everyone we talked to anonymous. I believe we have done both and we very much want your review of the draft report.
>
> I know that the document will take some time to review and I want to give you as much time as possible for your review. As such please send me your comments by February 21, 4 weeks from now. Please let me know:
>
> - Did we accurately capture your perspective(s) on buffers?
> - Are there other perspectives that you know of that we missed and should be included?
> - Do you feel we compromised your identity in any way that should be changed? If so, where in the document and how should this be changed?
> - Is there any missing information that would be helpful, or information that needs edits/correction?
> - Any other input?
>
> This document is currently being reviewed by the project Technical Review panel. Once I have the Tech Review and your reviews, a second draft report will be produced for review outside of the Project Team in other Great Bay watershed municipalities to test if it accurately captures watershed wide perspectives on buffers.
>
> Of course if you have any questions do not hesitate to ask. Many of you know that Lisa recently accepted a full time position with UNH Cooperative Extension. So while we have lost her from the Buffer Project, she is now a valued colleague and I will keep her apprised of the status of this report.

Attached are two docs. The BOB CA DraftF and the BOB CA Interim Report Appendices. The BOB CA DraftF is the main document that I'd like your feedback on, but welcome any input on the appendices.

Sincerely,

Steve

A second reminder was sent on 2/6/17 and a third reminder on 2/24/17.

Below is a summary of the responses received, with any potentially identifying content removed to preserve anonymity.

1. Five responses came in acknowledging receipt of the document, with no edits or comments in the document itself:
    - I think [community x] and their zoning is portrayed accurately in the report. I don't think anything was missed, not was [community x]'s identity compromised. There is nothing we add at this point.
    - Thank you for this important body of work. You all did a nice job capturing all sides of the community! I feel it accurately captures the variety of perspectives we hear here. I know with much of our future developments falling into the complex parcels with lots of wetland/buffer constraints we will really benefit from some guidance on the connection between buffers and water quality, LID, what types of BMPs would be needed to perform the functions we lose from our natural buffers.
    - I have not been ignoring your pleas, just don't have a spare moment. Now that this is the third request I took a few minutes to review. I'm sorry to say I do not have time to read cover to cover these 100 pages, but it looks like a great report, great information, and intense preparation! I have no comments and admire all your hard work!
    - I have printed the document to review, but things are crazy. I hope to have back to you by 3/3. Thanks.
    - No real edits but I believe you have captured most of the issues surrounding buffers (perhaps a little puny). Good job.
2. I have attached a marked up of the draft that identifies my comments. I hope this is what you had in mind for feedback. There is a tremendous amount of (very good) work in that draft. Hats off to you, Lisa and the other authors (and congratulations to Lisa on her new opportunity).
    - *Here are this interviewee's responses comments in red text:*
        - Page 16
            - Trust in science seems to vary depending on the issue. *Could this be because science has (intentionally) become more politicized?*
        - Page 17 - grammatical/wording edits
        - Page 18
            - Significant interest in allowing stormwater BMPs in exchange for reduced buffers; BMP's require long-term / perpetual maintenance and

there is plenty of evidence that the maintenance does not get done; some think mechanized design provides more opportunities to protect water quality than buffer restoration; stormwater requirements seem less controversial than buffers – developers feel they can recoup the costs of the engineered BMPs

- Page 19
  - Wetland regs are more controversial and difficult to comply with than shoreland regs. If wetland regs are more controversial it is partly because they actually allow more flexibility which results in more 'negotiation' and discretionary approvals/denials. Shoreland regs tend to dictate limits up front.
  - Ordinances are retroactive and responsive rather than proactive. This strikes me as unfair and/or inaccurate. It is more incumbent on applicants and their representatives to be proactive. The state and towns usually have no idea a project is coming.
- Page 20
  - Consider a more formalized process for Conservation Commission involvement. Some towns require a Special Permit or Conditional Use Permit from the PB or ZBA which requires interaction and thus empowers the CC.
- Page 21
  - Technical/mapping (subsection of "more information about" section)
    - More info about GIS data sources (e.g., wetland data sources don't line up; which to use?). None of these GIS resources replaces on-the-ground soil or wetland mapping for actual site/project design.
  - **Tools/resources:**
    - GIS (especially for code enforcement officers), and also more information about GIS data sources – wetland data sources don't line up; which to use? None of these GIS resources replaces on-the-ground soil or wetland mapping for actual site/project design

3. Thank you for sending along the draft community assessment. It is an incredibly impressive document full of very rich information. I've read through it three times, and probably could read through it a few more to capture everything. The challenges and barriers section I found very useful (even if slightly overwhelming). It provides us an opportunity to confront the challenges early on and not be surprised by them as they come up in a community project. Also the section on "More Information About" will hopefully guide some future research to answer those questions. I'm already thinking of ways to start incorporating some of these findings in [my work]. Below are the answers to your specific questions as well as some suggestions. Great work!
   - **Did we accurately capture your perspective(s) on buffers?** Yes.

- **Are there other perspectives that you know of that we missed and should be included?** Not that I can think of.
- **Do you feel we compromised your identity in any way that should be changed? If so, where in the document and how should this be changed?** No.
- **Is there any missing information that would be helpful, or information that needs edits/correction?** See below.
- **Any other input?**
    - Under section VI. Community Assessment: Buffer Ordinance Inventory Summary I'm assuming the first table does not include state standards? It's something we are struggling with... as well. For communities that don't have a specific shoreland ordinance, but rely on the Shoreland Water Quality Protection Act, does it make sense to say they don't have a shoreland buffer? I'm asking because again it's something we are trying to get our heads around...
    - The tables under VI. Community Assessment: Buffer Ordinance Inventory Summary could benefit from a brief description of the table. (i.e. Number of communities with a buffer (wetland or shoreland) within the subwatershed, etc.). Right now it's a little confusing to interpret. Also what is the difference between a 0 value and - value in the table? Looks like 0 is only reported when there is a value for the other (SL for example), but Lamprey River for limited cut/managed buffer has 0/0 reported.

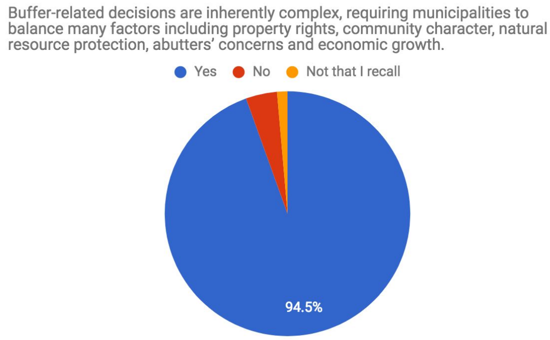
4. Two comments in the document:
    - "Yes!" in response to our goal statement.
    - Communities' perspectives and decisions about buffers: Have there been any discussions about using the term "buffer?" I find that the bulk of the public does not recognize that a "buffer" is a layer of protection along the shoreline. I'm not certain it's a "water word that works". Certainly ok for this publication – I just wanted to capture this thought.

Community Assessment Watershed-Wide Vetting Survey Results

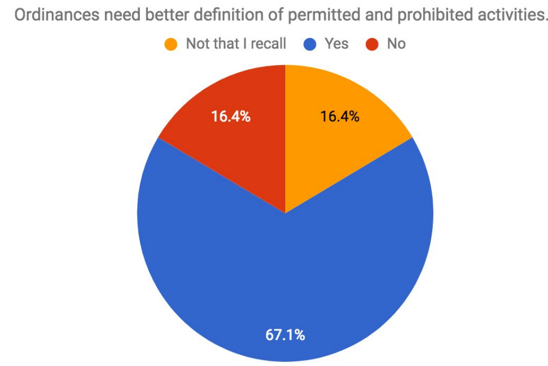
Questions 1 – 20: Summary of signals of agreement with buffer perspectives from the CA findings

Very high agreement	80-100%	General agreement	40-60%
Strong agreement	60-80%	Weak agreement	<40%

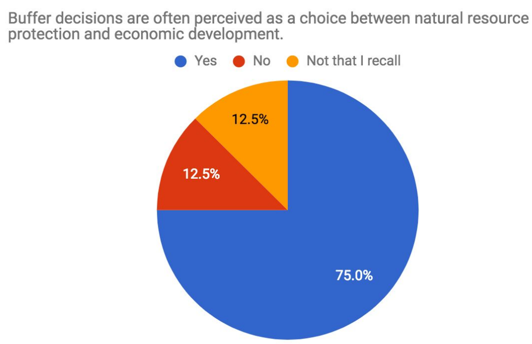
Q1 (73 responses)	Q2 (73 responses)



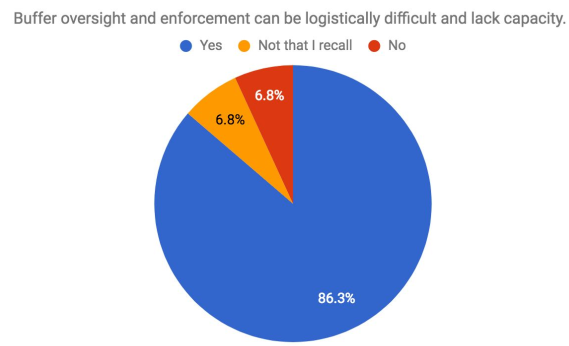
Q3 (72 responses)



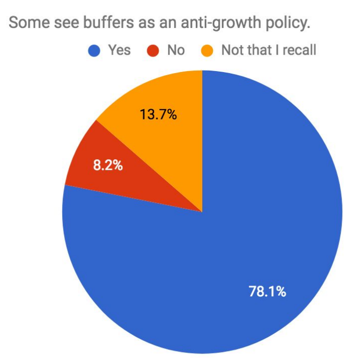
Q4 (73 responses)



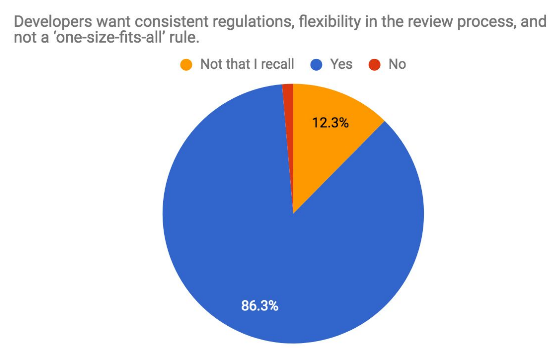
Q5 (73 responses)



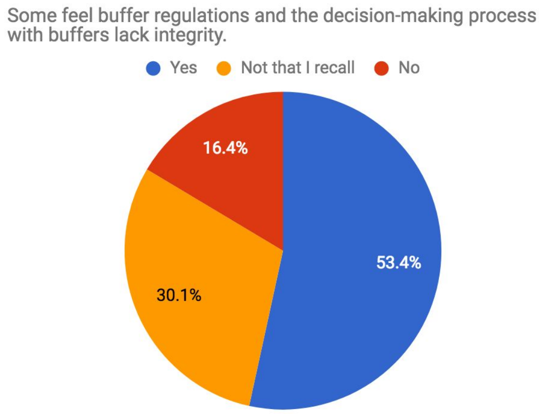
Q6 (73 responses)

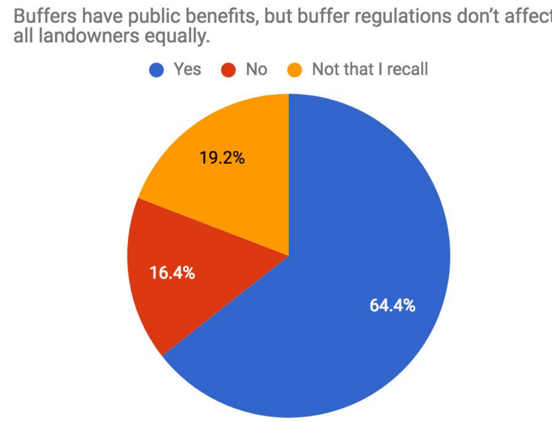


Q7 (73 responses)

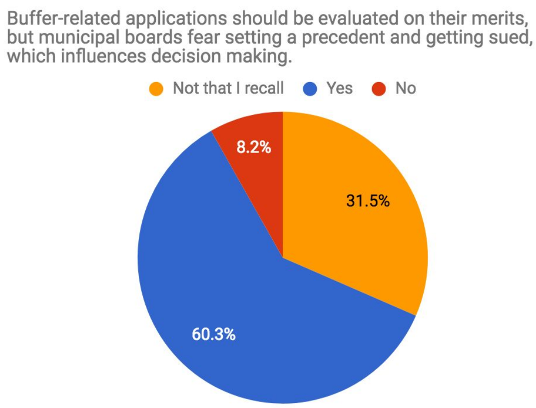


Q8 (73 responses)

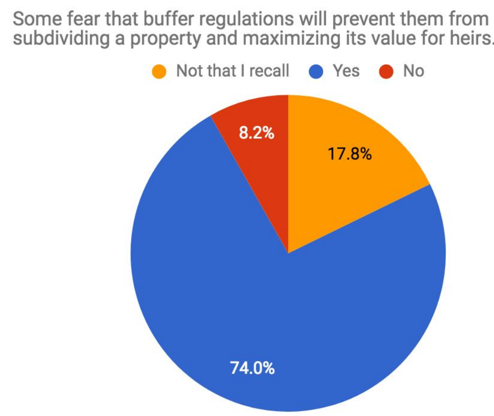




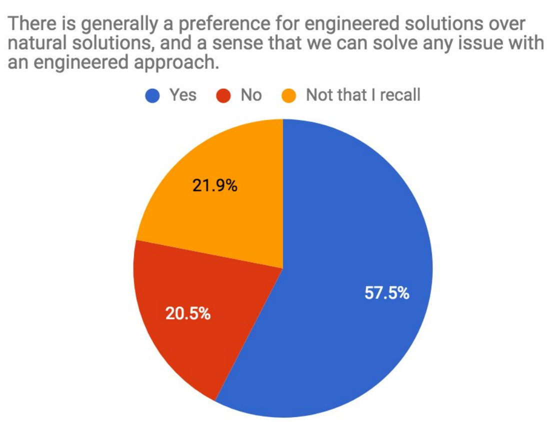
Q9 (73 responses)



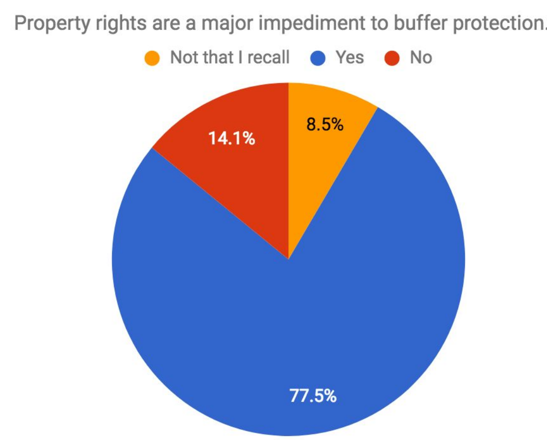
Q10 (73 responses)



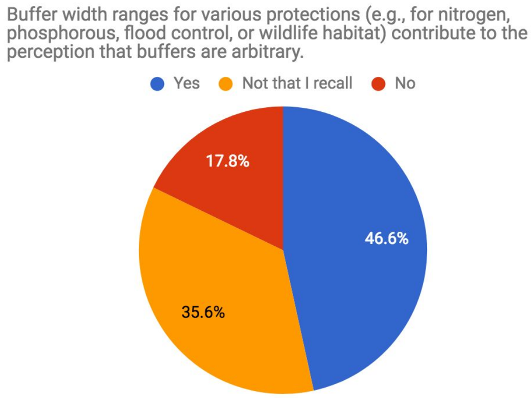
Q11 (73 responses)



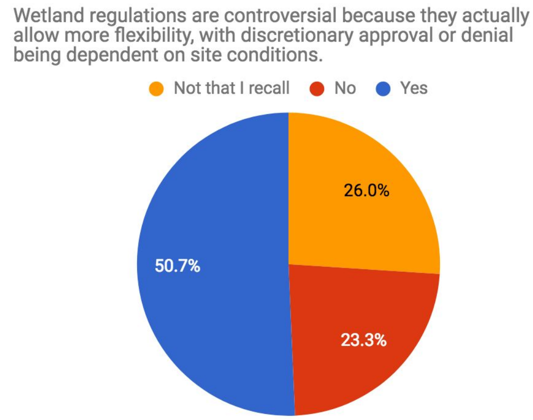
Q12 (71 responses)



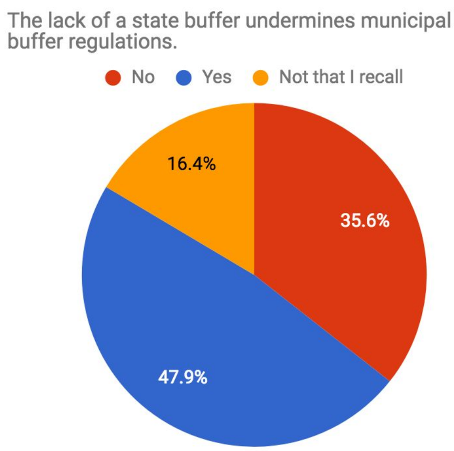
Q13 (73 responses)



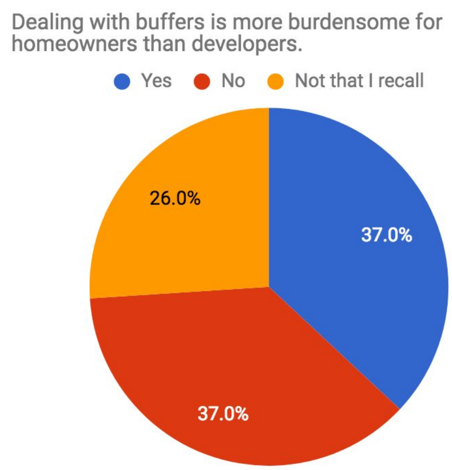
Q14 (73 responses)



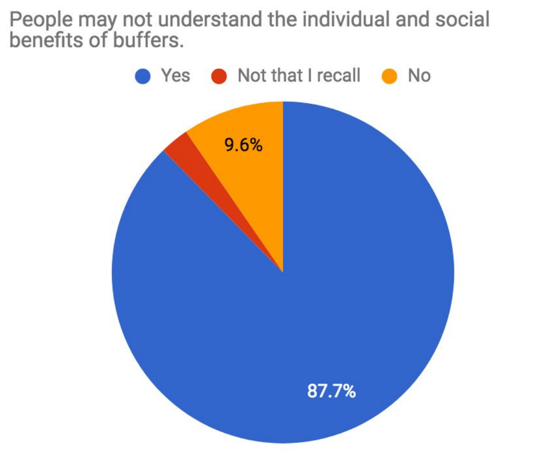
Q15 (73 responses)



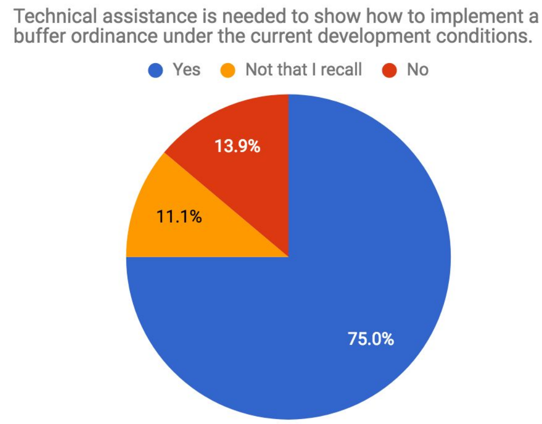
Q16 (73 responses)



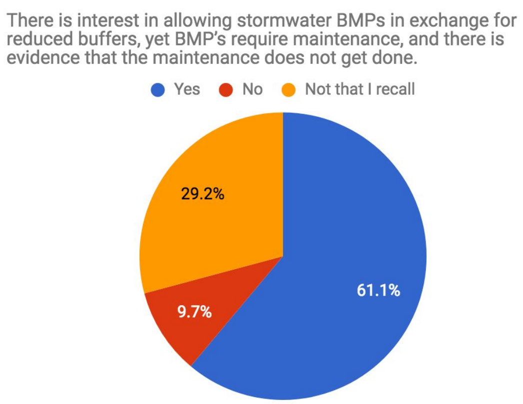
Q17 (73 responses)



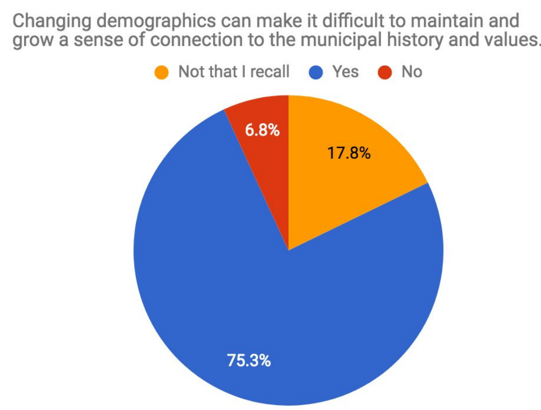
Q18 (72 responses)



Q19 (72 responses)



Q20 (73 responses)



21. What are the biggest buffer management issues in your municipality?

Responses are organized in categories, with some consolidation of similar ideas. 76 responses.

Category	Response
Municipal framework	Tax system that encourages maximum use of land and property rights law that supports the system
	Wetlands and setbacks
	Each town has its own set of regulations - there is no consistency.
	Fairness; balancing buffer protection with economic development
	It is difficult to apply buffers to lots with existing homes that are then subdivided, subjecting the mother lot to our buffer ordinance.

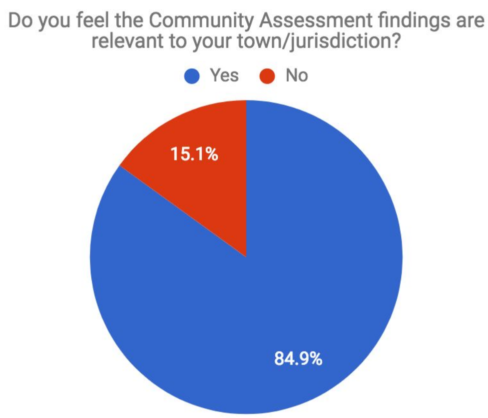
	Resistance
	Those advocating for sewer to allow for high-density apartments, which will erode the environment and require costly services; impacts from commercial development and increasing population
	Impacts from commercial development and increasing population
	Modifying/strengthening buffer regs in response to sea-level rise and increased rainstorm activity
	Limited resources
	Adequate regulations/definitions
	Zoning Board always gives variances for people to build in the buffers; Planning Board too easily grants special exceptions for construction in buffers
Enforcement	Enforcement, lack of maintenance, need for ongoing monitoring, oversight; lack of capacity/resources for administration and enforcement; compliance issues; logistical challenges in inspecting/enforcing
	Dependent on neighbor reporting neighbor - violations often go unreported/unnoticed
	Town looks to State to enforce buffer protection for prime wetlands and shoreline protection. Everything else regarding buffers is negotiable.
	Conservation commission has no teeth; voluntary; no dedicated staff person for conservation/buffers
	Delineation
	Trying to build capacity to ensure that existing state regs and town ordinances are followed.
Education	Interpreting DES regs; shoreline buffer regs are hard to understand; expensive to meet requirements
	Lack of awareness of buffer zones, lack of public understanding (i.e., of why we have buffers, value and importance of buffers, enforcement); local boards/commissions don't understand the irreplaceable value of natural systems and the benefits of buffers and open space
	That buffer issues are not arbitrary but relate to stated public policy objectives and science to provide their rationale and justification in the event of legal challenges
	Lack of education for residents, communities, and folks working with the community (municipality, realtors, landscapers, developers, etc.); getting the information out to residents in a non-biased way
Size of buffer and allowed uses/ activities	Flexibility would be easier with a higher standard. Buffers are too small to protect the resource.
	Have a wetland building setback but no buffers. No protection for vernal pools (and aren't mapped).
	The one-size-fits-all application of buffer regulations does not work to the best interest of the environment and the landowner in all cases.
	Difference between state and municipal buffer requirements.
	Establishing buffers for development projects and for timber harvesting.
	We have defined setback requirements in most cases and address buffers on individual plans. Buffer BMP recommendations would be helpful.
Agenda-driven	Buffer regs being used by "no growth" groups to stifle development and prevent landowners from realizing their total land value
	Landowner rights/property right control issues; people do not want any rules applied to their property that prevent them from doing anything they want to do. Live Free or Die mentality.
	Although developers know they have to deal with buffer ordinances, the citizenry feel regulations are overzealous and impeding projects and infringing on property rights.
	Pro-development mindset; developers want to extend development within buffers.
	Balancing property rights, public benefit, development constraints, enforcement capacity, and individual attitudes. It is definitely not a "one issue" problem but a multi-faceted challenge. While education is important it does not seem to be solving the problem. The property rights issue seems to

	trump the knowledge that they are important.
	Unwillingness of homeowners being told what they can do with their property. Desire to run lawns down to water, hardscape, and have docks. People preferring formal landscape plans to natural habitats. Herbicides and/or fertilizers.
Condition or amount of buffer	Most of the buffers in town are already compromised. While buffer regulations were strengthened in 2017, they are not retroactive on areas where buffers are already compromised.
	Two major rivers plus extensive wetlands (unmapped and undefined locally) impact much of the town's effort to make decisions for development vs. conservation.
	Large buffer impacts in new developments due to the remaining developable land being full of wetlands and perception that the Con Com is anti-development
	Sites already existing within buffers -- sometimes for many years
	Quality of wetland versus management relevance
	Lack of flexibility based on the quality/type of resource being buffered, and uses within the buffer (e.g., lawn versus more natural cover)

Don't know/None/I'm not sure (8 responses)

22. Do you feel the Community Assessment findings are relevant to your town/jurisdiction?

73 responses; very high agreement



23. Please list any key perceptions related to buffers that you have heard in your municipality that were not a part of this survey.

Responses are organized into basic categories, with some consolidation of similar ideas. 34 responses.

Category	Response
Agenda-driven	Increased buffer regulation is a slippery-slope toward state rather than local control of town destiny.
	Some have talked about balancing the rights of the property owners vs. the public interest in resource protection, but I don't think it is as prevalent here as in other less liberal parts of the State.
	Buffer issues generate us vs. them attitudes (i.e., property rights vs. resource protection).
	Buffers are unnecessary. Some distrust science and think that buffers don't matter.
	Buffers are perceived as a taking / Buffers limit landowner rights.
	Buffers are valuable and necessary to protect the environment/natural resources and infrastructure.

	People love buffers.
Municipal process	The nibbling away at the edges - i.e., homeowners that return for ZBA adjustments multiple times
	The number of and the varying setbacks of the buffers.
	Existing homes should be grandfathered from any buffer ordinance changes that are stricter. Perception of unfairness - i.e., “my neighbor was able to do it…”
Size of buffer	Difference of opinion re: appropriate size
	Resistance to enacting buffer regulations based on wetland functions and values.
	Additional buffers for unique wetland features like cedar swamps and vernal pools.
	All wetlands are treated the same, regardless of benefit to public or environment.
	Arbitrary buffer widths determined through political process (what can get passed). Better to define widths based on primary intent for protection (i.e., water quality vs. wildlife would have different widths). Highlight most important wetland function/value and set appropriate width (based on literature). Less-defined regulation for planning, but allows for case-by-case considerations.
Education	New residents moving into existing housing aren’t educated about shoreline protection or buffer regs. People moving in from areas without water resources have no knowledge of buffers.
	My own municipality is doing a poor job of communicating with citizens. I have "heard" very little.
Enforcement	Penalties are not strong enough or enforced when buffers are breached
Other	Right of ways
	Vernal pool issues

None that I know / N/A (8 responses)

Appendix F. Additional Maps for Subwatershed/Community Selection

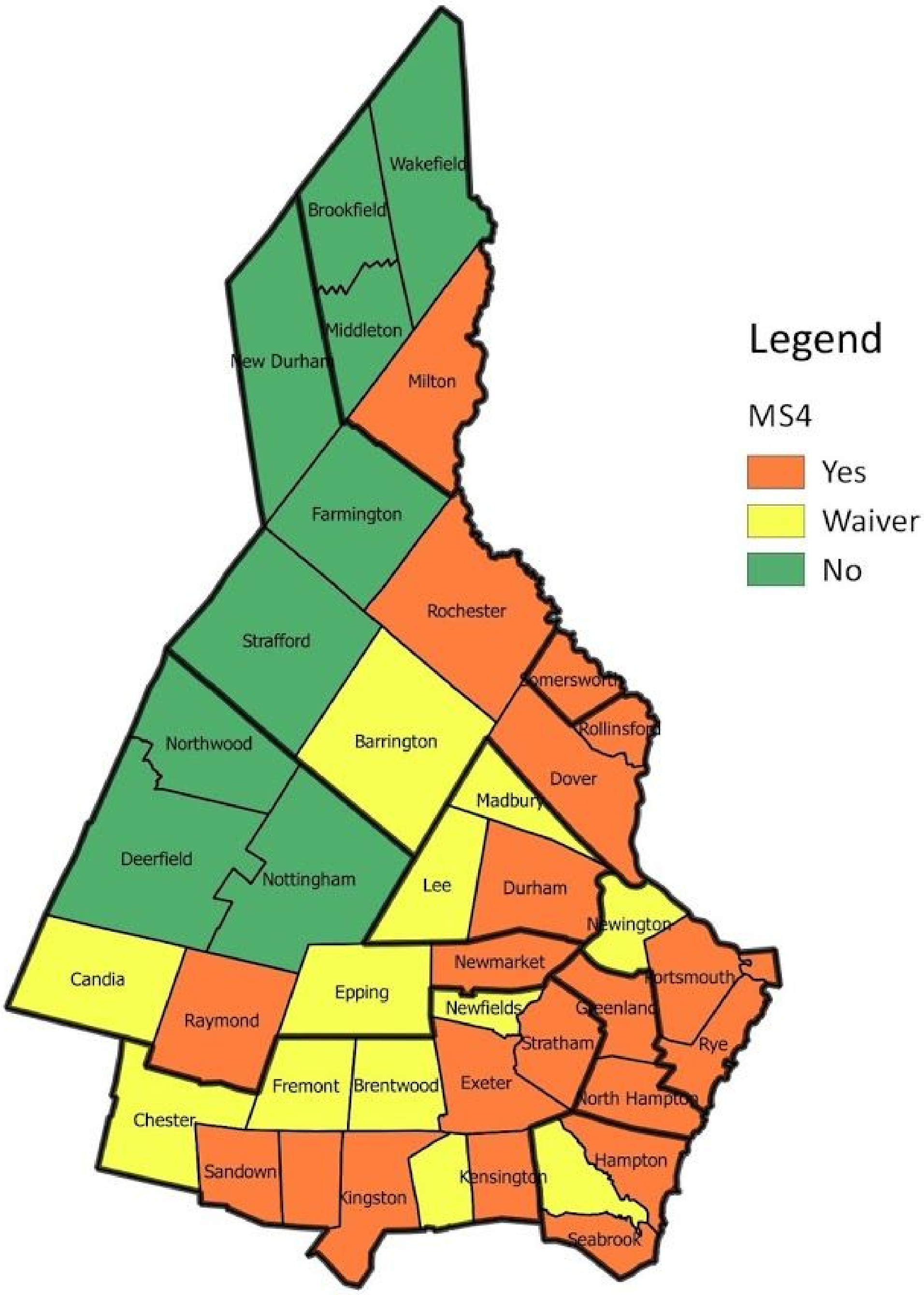


Figure 1. Map of MS4 permit status of Great Bay watershed communities.

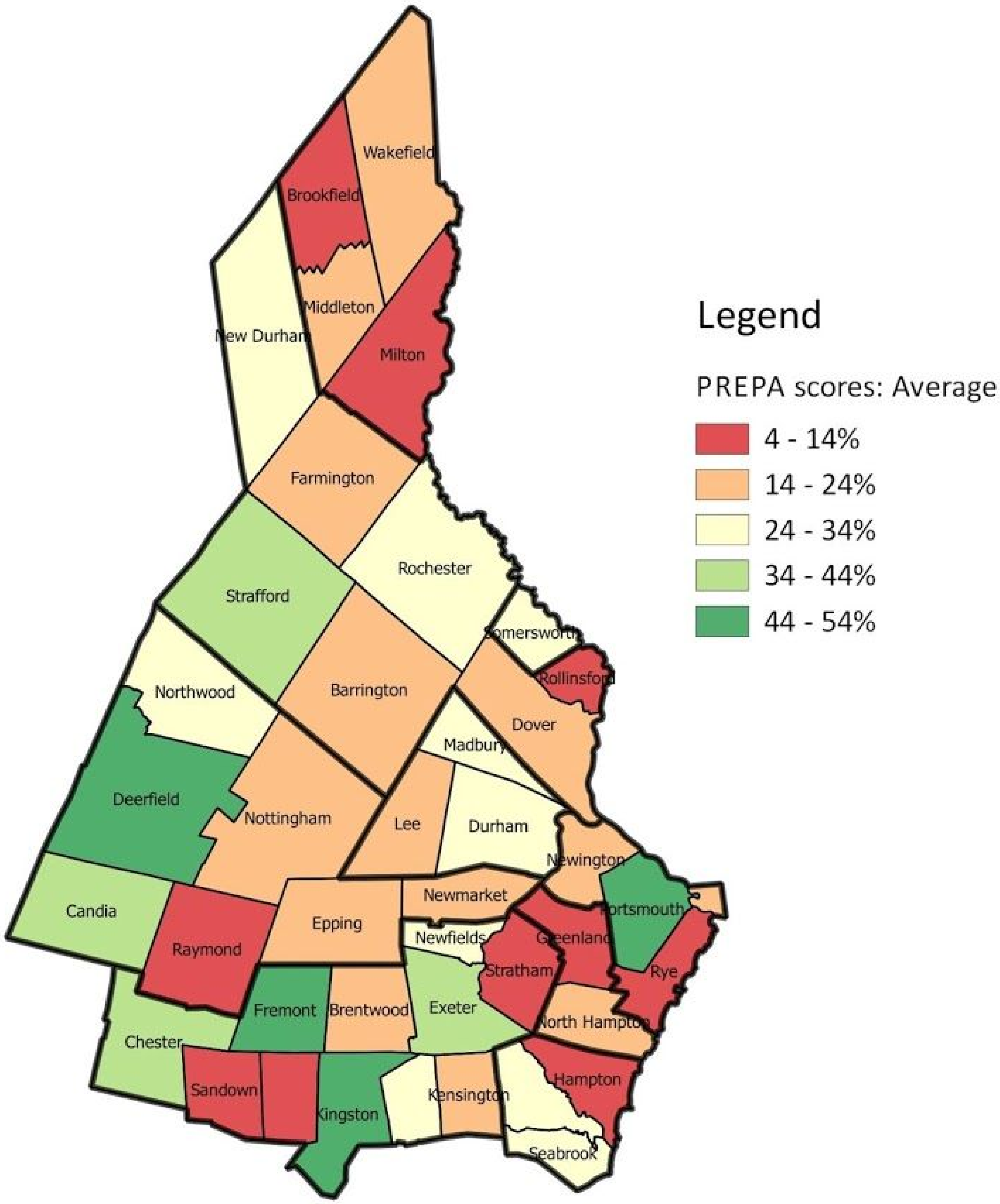


Figure 2. Average PREPA 2015 report card scores for Great Bay watershed communities.

Appendix G. Interview Findings Conceptual Model Narrative & Guidance

Description

Here is a basic conceptual model for factors in buffer action, based on the Buffer Options for the Bay Project's Community Assessment interviews with municipal staff and volunteers, developers, consultants, planners, and other stakeholders. The full Prezi-based conceptual model with additional details can be found here: https://prezi.com/o-xruprh6jrp/. Trust is at the center of our findings, with four main elements along the two major axes that need to be balanced, like a scale or a spinning top: Municipal Context, State Context, Community Members' Values, and Community Members' Knowledge and Awareness. There are also several external factors that can play a role, including: a local water contamination event or history of local pollution problems; science/information; developers; and third parties (e.g., BOB partners).

How can this model be used?

This model provides a framework for understanding our interview findings, as well as a tool for discussing and designing potential interventions to support better buffer management.

- **This model can be used by the Buffer Options for the Bay Project Team partners to have a dialogue around how our individual work can and should fit together; where our strengths and**

weaknesses may be; an impact versus effort comparison of potential actions; and opportunities to focus and coordinate our efforts more efficiently for greater impact.

- **Individual partner organizations may use the model to think about how their efforts contribute to the overall picture and where to focus based on their areas of expertise, capacity, and strength.**

- **The model may be used to identify leverage points and opportunities in specific communities.** For example, if we know that Community A already has a strong culture of valuing water resources, we can probably focus on some of the other components. But if Community B is severely lacking a sense of connection to these resources, that is a critical piece to try to build. If there isn't a strong community awareness of and value for the resources buffers are trying to protect, trying to work on a statewide or municipal buffer policy may not be successfully passed or enforced, so it is important to keep all of these factors in mind prior to and while implementing any particular action.

Guiding questions to walk through the model

If thinking more generally about your work's intersection with buffers:

1. Where does my (or my organization's) strength/expertise/capacity fit into this model?
2. Which areas are gaps in my (or my organization's) particular focus, expertise, or capacity? Do I know other partners who have strengths or capacity to fill these gaps?
3. Do I need to adjust my approach in any way based on this model?

If thinking about approaching buffer-related work in a particular community:

1. What do I know about the municipal context, community members' values, community members' knowledge and awareness, and the municipality's relationship with the state?
2. What do I know about issues of trust in this community? (e.g., certain partners or sources of information that are more trusted than others; trust issues between particular boards; trust of the State government; trust of science; etc.)
3. What else do I need to find out?
4. What areas jump out as potential leverage points or opportunities? Consider comparing a suite of potential actions you could take based on effort vs. impact.
5. Given what I know about this community, how does that affect the approach to working on buffers here? For example, is there one key area that needs work (e.g., building community members' level of knowledge and awareness, before trying to tackle a new municipal ordinance)? Can I anticipate and proactively address any potential roadblocks?

Appendix H. Buffer Ordinance Inventory Summary

The following summary of Great Bay municipalities' buffers is based on a review of each municipality's zoning ordinance. This review was focused specifically on the presence or absence of a vegetated buffer (either a no cut-no disturb buffer or a limited cut/managed buffer, or some sort of combination of the two). Setbacks (e.g., for structures or septic systems) are not included. Wetland and shoreland buffers are distinguished, since they often (though not always) are treated separately in municipal zoning ordinances.

Note: This inventory has not been verified with communities, and just represents a "snapshot" of the municipal ordinances as of December 2016 (based on the most recent version of the ordinance found online). In addition, the widths of each community's buffer vary, as well as what the buffers apply to (see the full inventory table for more detail).

In general, there seems to be much more consistency between the Maine municipalities' ordinances in relation to buffers; the buffer widths and language are often very similar if not the same. There is much greater variability between the New Hampshire municipalities' buffers.

	New Hampshire (42)		Maine (10)	
	WETLANDS	SHORELAND	WETLANDS	SHORELAND
No Cut-No Disturb Buffer	15	13	-	-
Limited Cut / Managed Buffer	13	13	8	2
No Buffer	11	11	-	-
Combination (vegetated + limited)	3	2	2	8
Just references SWQPA	0	3	-	-

Here is the breakout by subwatershed:

Subwatershed *(includes ME and NH municipalities)*	**No Cut-No Disturb Buffer**	**Limited Cut / Managed Buffer**	**No Buffer**	**Combination (no-cut + limited cut)**	**Just references SWQPA**
	WL / SL*	WL / SL	WL / SL	WL / SL	WL / SL
Cocheco	4 / 3	3 / 2	0 / 2	-	-
Exeter-Squamscott	6 / 5	3 / 2	2 / 4	-	-
Hampton-Seabrook	1 / 1	2 / 2	-	-	-
Lamprey	3 / 3	0 / 0	4 / 2	-	0 / 2
Oyster-Bellamy	1 / 1	2 / 3	1 / 0	-	-
Salmon Falls	0 / 0	9 / 5	3 / 1	1 / 6	1
Winnicut	1 / 1	0 / 0	1 / 1	-	-
Coastal	0 / 0	3 / 2	0 / 1	3 / 3	-

*WL / SL = Wetland / Shoreland

WETLANDS

	No Cut-No Disturb Buffer	Limited Cut / Managed Buffer	No Vegetated Buffer	Combination of No Cut-No Disturb and Limited Cut / Managed Buffer
NH	Brentwood Deerfield Exeter Greenland Hampton Falls Kensington New Durham Newfields Newmarket Northwood Rochester Rollinsford Sandown Strafford Stratham	Barrington Chester Dover Durham Farmington Fremont Hampton Kingston Milton New Castle Rye Seabrook Somersworth	Brookfield Candia Danville East Kingston Epping Lee Middleton North Hampton Nottingham Raymond Wakefield	Madbury Newington Portsmouth
ME		Acton Berwick Eliot Lebanon North Berwick Sanford Wells York		Kittery South Berwick

SHORELAND

	No Cut-No Disturb Buffer	Limited Cut / Managed Buffer	No Vegetated Buffer	Combination of No Cut-No Disturb and Limited Cut / Managed Buffer
NH	Brentwood Candia Deerfield Exeter Farmington Greenland Hampton Falls Kingston New Durham Newfields Northwood Rochester	Chester Dover Durham Fremont Hampton Lee Middleton Milton New Castle Rye Seabrook Somersworth	Barrington Brookfield Danville East Kingston Epping Kensington Newington North Hampton Nottingham Rollinsford Sandown	Madbury Portsmouth

	Stratham	Strafford	*Communities that just reference SWQPA*:* Newmarket Raymond Wakefield	
ME		Acton Berwick Eliot Kittery Lebanon North Berwick Sanford South Berwick		Wells York

*SWQPA = Shoreland Water Quality Protection Act

Appendix I. Opportunities For BOB Team To Use These Findings

Policy (NHDES)

- Consider interviewees' perspectives about policy options, what works and what doesn't, and what the challenges are – especially around a statewide buffer.
- Consider policy options that incentivize buffers and/or provide flexibility.
- Provide outreach to potential applicants about application requirements and process.
- Involve developers, consultants, and other stakeholders in discussions about buffer policy.
- Identify opportunities to streamline the permitting process.
- Ensure that communities feel supported by the State to enforce their own regulations; address any potential conflicts or issues of overlap between municipal and state regulations
- Allocate more resources to State oversight and enforcement. Review permit denial rates, violation rates, and enforcement rates, and identify opportunities for improvement. Consider opportunities to support municipal enforcement capacity as well.

Land Conservation (TNC, GBNERR)

- Focus land acquisition on buffer areas and support buffer restoration projects.
- Consider these findings in outreach and communication efforts to municipalities and other stakeholders (e.g., some communities feel they already have 'enough' conservation land, so maybe they don't need buffers). Collaborate with partners to coordinate messaging and prioritize efforts.
- Build awareness about the economics of open space and stewardship best management practices.
- Make sure municipalities and landowners are aware of conservation opportunities.

Municipal Training/Outreach (GBNERR, PREP, Stormwater Center)

- Use these findings to design outreach/education efforts to address communities' needs.
- Recruit local buffer leaders and recognize champions.
- Use the inventory of municipalities' buffer ordinances to determine where to focus efforts, and to point towards "progressive" communities as examples.
- Link buffers to the human health/welfare benefits as well as the environmental benefits, and work with communities to determine how protective they want to be.
- Develop a buffer outreach plan with strategies, deadlines, and town-specific approaches.
- Make sure communities are aware of existing resources and technical assistance providers (e.g., regional planning commissions can provide GIS capacity).
- Engage developers, consultants, and other stakeholders in buffer-related outreach and projects.
- Address capacity gaps and challenges identified by interviewees (e.g., legal questions, enforcement).
- Start with communities' values, and show connections between buffers and protecting those values (see suggestions on page 2).

Research (Stormwater Center, Clark University, GBNERR, UNH)

- Integrate the ecological, economic, and social science to answer buffer-related questions.

- Determine whether and how to address information and product needs expressed by interviewees.

Communication (all)

- Consider these findings when communicating with stakeholders about buffers (and other natural resource management issues) (e.g., base buffer-related messaging around communities' values).
- Address challenges with communicating science (e.g., range of buffer width recommendations creates a sense of uncertainty).
- Consider whether and how to address the product needs identified by interviewees.

Buffer Options for the Bay: Economic Valuation of Water Quality Ecosystem Services in New Hampshire's Great Bay Watershed

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Executive Summary

Land that borders New Hampshire's rivers, streams, and estuaries provides many ecosystem services including water purification, wave and storm surge protection, and wildlife habitat. Management of these lands can be challenging as residential development, agriculture, and other intensive land uses can impede the generation of these services, leading to management tradeoffs. Traditional economic assessments sometimes ignore the value of ecosystem goods and services, because these services are not bought and sold through formal markets. Nonetheless, these services have economic value that can be quantified. Non-market valuation quantifies the benefits and costs associated with the goods and services provided by nature in order to improve decision making regarding their use and conservation. Benefit transfer is an economic valuation method that uses results from preexisting primary research studies at one or more "study" sites to predict economic values at other non-studied "management or policy" sites. Benefit transfer is often used when the necessary time or funding resources are not available to conduct an original primary study at the site(s) expected to be impacted by future management activities or policy interventions. This report describes the generation of a water quality benefit transfer function using meta-analysis techniques, details the step-by-step process used to apply this transfer function including the calculation of a water quality index (WQI), and presents value forecasts for a suite of buffer-related water quality change scenarios.

This analysis was commissioned by Buffer Options for the Bay (BOB), a grant-sponsored collaboration of public, academic, and nonprofit organizations dedicated to enhancing the capacity of New Hampshire stakeholders to make informed decisions that make best use of buffer lands to protect water quality, guard against storm surge and sea level rise, and sustain fish and wildlife in the Great Bay region. The project defines buffers as naturally vegetated segments of land directly upslope of a water resource, such as a lake, stream, river, pond, estuary, or other wetland type.

This analysis is intended to be a resource for the organizations involved in the BOB project and others engaged in helping communities and individuals with decisions related to buffer management and policy. The team also has conducted analyses of the biophysical and social scientific literature that underpins buffer management, a buffer-focused GIS analysis of the Great Bay region, and an assessment of the barriers and opportunities related to buffer management in four communities in the Exeter/Squamscott subwatershed.

The results of these analyses are captured in individual reports, available at www.bufferoptionsnh.org/reports. They also have been integrated into an online framework intended to inform discussions around buffer management in the region, open the door to new and needed research; and encourage strategic investment. Finally, the team created a collective action plan to encourage collaboration among outreach professionals as they work with towns on advancing effective buffer policy and practice at the community level.

The meta-regression analysis in this report used 140 observations from 51 primary stated preference valuation studies published between 1985 and 2013 that estimate per household willingness to pay (WTP) for water quality changes in US water bodies that affect a variety of ecosystem services including aquatic life support, recreational uses, and non-use values. WTP reflects the amount of money that households would be willing to give up—for example in taxes and fees—in order to obtain a specified gain in ecosystem services (or to prevent a loss), rather than go without. The estimated benefit transfer function explains household WTP using information on the geographic region and focal water body, the baseline focal water body condition and evaluated water quality change, the affected human populations, and potential substitute resources and complementary land uses.

The benefit transfer function was applied to a suite of water-quality change scenarios that focus on three water body resources within the Great Bay watershed: the Great Bay Estuary itself (not including tributaries), and the freshwater and tidal portions of the Exeter-Squamscott River. The choice of the Exeter-Squamscott River was driven by the appeal of coordinating this economic analysis with work being done by the project team's Community Assessment group. For the Great Bay Estuary, we estimated WTP for water quality improvements at three different socio-economic scales: residents in N.H. towns immediately adjacent to the bay, residents of N.H. towns within the entire Great Bay watershed (approximated by Rockingham and Strafford counties), and all residents of the state of N.H.. For the freshwater and tidal portions of the Exeter-Squamscott River, we evaluate willingness to pay for residents in towns adjacent to the upper or lower portion of the river, respectively. Because information on specific policy-driven changes in buffer quantity, quality, and location (as well as the associated changes to water quality) was not available for this project, we investigated a range of potential water quality improvements: 3, 5, 7, and 9-point increases on a 100-point water quality index (WQI) beyond current conditions. We also investigated a set of policy scenarios that considered the potential ramifications of a "do nothing" buffer policy that would lead to a reduction or degradation in the existing supply of vegetative buffers and a subsequent reduction in water quality. For these hypothetical scenarios, we forecast annual household WTP to maintain water quality at its current level rather than allowing it to fall below the minimum WQI threshold required for swimming.

The benefit transfer produces a wide range of willingness to pay forecasts for water quality improvements in New Hampshire's Great Bay watershed, with results varying as expected over the 50 unique scenarios. Annual household WTP increases as the size of the water quality improvement increases for all focal water bodies. For the Exeter-Squamscott River subwatershed, values range from $39 to $54 per household per year for households in adjacent communities. While the baseline water quality is better and the size of the improved water body is larger in the Exeter River, median household income is higher in communities along the Squamscott River. Thus, despite differences in scenario parameters, tradeoffs among those parameters can result in similar WTP forecasts. Annual household WTP is greater ($62-$85) for improvements to the entire Great Bay versus the smaller Exeter-Squamscott regions, despite the baseline water quality being better and median household income being lower, due to the larger size of the improved water body and also due to the relative lack of a substitute for the Great Bay within New Hampshire. As the market area for the Great Bay increases from adjacent towns to surrounding counties to the entire state of N.H., annual household WTP, reflecting a pattern in which people who live farther away, value improvements to the Great Bay less than those living closer, *ceteris paribus*. Results from the "Maintain Swimmable" scenarios, which forecast willingness to pay to maintain water quality at its current baseline level rather than allowing it to fall below 70 on the 100-point WQI, are also intuitive. Households are willing to pay more to maintain a higher baseline water quality level across all water bodies.

WTP aggregated over an entire market area (or population) can vary due to differences in per household WTP, or due to differences in the number of households in the market area. For example, despite comparable household WTP measures, regional WTP values aggregated across all households in the adjacent communities for the three-town Squamscott River region ($300-600K) are lower than values for the larger seven-town Exeter River region (~$1 million) due to the larger number of households in the Exeter region. Aggregated values for the seven communities immediately adjacent to the Great Bay ($1.5-2.8 million) exceed those of the Exeter-Squamscott region, due to both larger household values and the larger number of households. Further, despite lower household WTP values for the larger market regions, the much larger number of households in the two counties and the entire state results in dramatically higher aggregate regional WTP values.

While we elected to include statewide scenarios in our analysis to show how WTP values can change over larger market areas, it is unclear whether any statewide buffer policy would focus on the Great Bay estuary alone. It is more likely that a statewide buffer policy would be implemented across all water bodies in the state. Thus, the more relevant aggregate WTP comparison would be among adjacent communities ($1.5-2.8 million) and the two counties that encompass the entire watershed ($9.5-17.1 million). The larger two-county values would be useful for funding buffer policies or management activities that impact the Great Bay and all its tributaries, while the small adjacent community values would be more appropriate for small bay shoreline projects.

Interpretation of all the forecasted (i.e., transferred) values should be handled with caution. Results are not exact, but rather approximations of public values for water quality improvements that can be used to guide resource management and policy decision making. It is important to recognize that the values are representative of what households would be willing to pay for particular water quality improvements, but there is no guarantee that those funds would actually be sufficient to support the level of buffer restoration or other activities that actually improves water quality by the desired amount. Of course, the opposite could be true as well—funds equaling aggregated WTP might support management activities that exceed the desired level of water quality improvement. That is, WTP reflects the *value* of an improvement to people, not the *cost* of obtaining those improvements.

Quantitatively linking the change in the quantity or quality of buffers that would result from a specific management action to a direct consequential change in the WQI is challenging and beyond the scope of this analysis. As such, this economic analysis forecasts values for water quality improvements directly, and then systematically explores a range of modest changes in water quality from the WQI baseline for each focal resource. The role and potential contribution of buffers in driving changes in water quality of this magnitude can then be explained after the fact, lessening potential criticism that our modeled scenarios are based on too many biophysical assumptions (e.g., that a buffer of a particular type and location would lead to a particular water quality improvement). The WQI information provided can point practitioners to particular pollutants and could be a good place to start when identifying potential buffer actions, however, it is ultimately necessary to integrate the economic valuation results presented here with the results of biophysical water quality modeling scenarios in order to make well-informed decisions.

Finally, this economic valuation does not inform the decision maker regarding which set of management activities to engage in; that is, there is no cost analysis of buffer management. This analysis quantifies benefits only. A full cost-benefit analysis is often required to determine whether the benefits of specific management actions exceed the costs, although in some cases it may be obvious that the benefits reported here will outweigh the costs without conducting a formal cost analysis.

1. Introduction

The overall goal of the Buffer Options for the Bay project is to enhance stakeholder capacity to make informed decisions related to the protection and restoration of riparian buffers surrounding New Hampshire's Great Bay. To this end, the project conducted an integrated assessment that combines, interprets, and communicates science-based information. This information is focused on regulatory and non-regulatory options for protecting and restoring buffer zones around the Great Bay, and addressing the challenges necessary to do so. This report describes the methods and results of the economic ecosystem service valuation component of the project.

Traditional economic assessments sometimes ignore the value of ecosystem goods and services, because these services are not bought and sold through formal markets. Nonetheless, these services have economic value that can be quantified. Valuation is often conducted in order to improve decision making regarding the use and conservation of natural assets, and typically quantifies willingness to pay (WTP) for well-defined measures of losses or gains in specified ecosystem services (or the assets that provide them). Benefit transfer is an economic valuation method that uses results from preexisting primary research studies at one or more "study" sites to predict economic values at other non-studied "management or policy" sites (Johnston and Wainger 2015). Benefit transfer is often used when the necessary time or funding resources are not available for an original primary study at the site(s) expected to be impacted by future management activities or policy interventions. Benefit transfer may be conducted using multiple different approaches (Johnston et al. 2015). The benefit transfer method used here involves two major steps: the use of meta-analysis techniques to generate a flexible, transferable benefit function from previous studies that estimate WTP for a quality change of interest, and the application of this benefit transfer function to multiple management scenarios. A scenario definition includes descriptions of the focal resource, the level of improvement in that resource, and the market area, which identifies the human population affected by the change in quality.

In the analysis reported here, we focus on the economic values associated with water quality improvements resulting from the protection or restoration of vegetated buffers within New Hampshire's Great Bay ecosystem. The focal resource could be the entire Great Bay, a portion of the bay, a particular tributary that leads into the bay, or a group of water bodies. The level of water quality improvement is typically determined by combining socio-economic and biophysical modeling or expert knowledge that relates a new buffer policy or set of management activities to changes in buffers (e.g., size, quality, and location) to changes in water quality. The market area could include just those communities adjacent to the water body of interest, communities in a particular county or group of counties, or the entire state of New Hampshire.

This report describes the generation of a water quality benefit transfer function using meta-analysis techniques, details the step-by-step process used to apply this transfer function with sufficient detail such that the function can also be used after the Buffer Options for the Bay project ends, and presents economic value forecasts for a suite of buffer-related water quality change scenarios based on three focal resources (Great Bay Estuary, Squamscott River, and Exeter River) and three affected populations (adjacent communities, watershed communities, and the entire state of New Hampshire). Because information on policy-driven changes in water quality was not available, we selected a range of water quality improvements to investigate.

2. Water Quality Benefit Transfer Function

When conducted using meta-analysis (as done here), the generation of transferable benefit functions from existing economic valuation studies involves three main steps: data synthesis, metadata construction, and meta-regression model specification and estimation (Johnston et al. 2015). The process begins with the selection, screening, and coding of primary economic valuation studies conducted over different sites and populations, each providing one or more estimates of positive or negative economic values associated with changes in environmental quality. Here, the metadata were drawn from primary stated preference valuation studies that estimate per household willingness to pay (WTP) for water quality changes in US water bodies that affect a variety of ecosystem services including aquatic life support, recreational uses (e.g., fishing, boating, and swimming), and nonuse values (e.g., biodiversity). The metadata selection excluded revealed preference studies, as they do not include nonuse values, and studies focusing primarily on drinking water supplies, as these tend to be very different from studies that focus more broadly on use and nonuse values. Studies were screened to ensure that necessary data (e.g., identification of the improved water body, the specific water quality change being valued, and details of the sampled population) was provided and that the WTP measure used could be linked to water quality changes measured on a standard 100-point Water Quality Index (WQI) that relates water quality pollutant concentrations to water body suitability for human uses.[1] These primary study selection restrictions allowed observations from multiple studies to be combined into a single meta-dataset suitable for analysis using standard statistical regression techniques. The final metadata included 140 observations (i.e., WTP estimates) from 51 stated preference studies published between 1985 and 2013 (Table 1), noting that multiple observations can result from a single study because of variations in key valuation characteristics including the spatial extent of the water quality change, the sampled populations, the number and type of water bodies affected, or the specific affected recreational uses.

The dependent variable used in our meta-regression model is the natural log of per household WTP for water quality improvements. Independent variables expected to explain variation in household WTP (and included in the model) characterize (1) the geographic region and focal resource, (2) the sampled and affected populations, (3) the baseline focal resource condition and evaluated water quality change, (4) potential substitute resources and complementary land uses, and (5) the primary study methodology and year (Table 2). While the primary studies provided values for most independent variables, additional development of the metadata was required. This included calculations of spatial metrics using GIS techniques, lookup of census data, and translations of verbal descriptions (e.g., "swimmable") or ordinal rankings (e.g., poor/fair/good) of water quality into the 100-point WQI, was required. In addition, all monetary values were adjusted to 2007 US dollars, once again to enable standard regression techniques.[2]

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[1] Details of the Water Quality Index (WQI) and its use in benefit transfers are provided in section 3.
[2] The full metadata development process is described in Johnston et al. (2016).

Three meta-regression model specifications were estimated based on the following general form:

$$\ln(WTP) = \text{intercept} + \Sigma \ \text{coefficient}_i * \textit{independent-variable}_i$$

(1)

The three models differ by which composite variable is used to express the relationship between geospatial scale (the size of the water body or surrounding land area) and market area (the size of

Table 1. Primary Studies in Metadata (mean WTP is per household per year in 2007 USD).

Reference†	Obs.	State(s)	Water Body Type(s)	Mean WTP
Aiken (1985)	1	CO	River and lake	193.18
Anderson and Edwards (1986)	1	RI	Salt pond/marsh	180.71
Banzhaf et al. (2006)	2	NY	Lake	57.47
Banzhaf et al. (2011)	1	VA, WV, TN, NC, GA	River/stream	31.30
Bockstael et al. (1988)	1	DC, MD, VA	Estuary	149.03
Bockstael et al. (1989)	2	MD	Estuary	158.30
Borisova et al. (2008)	3	WV, VA	River/stream	44.94
Cameron and Huppert (1989)	1	CA	Estuary	49.53
Carson et al. (1994)	2	CA	Estuary	59.40
Clonts and Malone (1990)	3	AL	River/stream	103.20
Collins and Rosenberger (2007)	1	WV	River/stream	18.19
Collins et al. (2009)	7	WV	River/stream	120.52
Corrigan et al. (2009)	1	IA	Lake	123.30
Croke et al. (1986)	9	IL	River/stream	77.47
De Zoysa (1995)	1	OH	River/stream	70.18
Desvousges et al. (1987)	12	PA	River/stream	59.19
Downstream Strategies (2008)	2	PA	River/stream	12.74
Farber and Griner (2000)	6	PA	River/stream	76.16
Hayes et al. (1992)	2	RI	Estuary	397.44
Herriges and Shogren (1996)	2	IA	Lake	134.55
Hite (2002)	2	MS	River/stream	60.08
Huang et al. (1997)	2	NC	Estuary	258.65
Irvin et al. (2007)	4	OH	All freshwater	21.67
Johnston et al. (1999)	1	RI	River/stream	180.95
Kaoru (1993)	1	MA	Salt pond/marsh	218.61
Lant and Roberts (1990)	3	IA, IL	River/stream	143.93
Lant and Tobin. (1989)	9	IA, IL	River/stream	55.63
Lichtkoppler and Blaine (1999)	1	OH	River and lake	41.93
Lindsey (1994)	8	MD	Estuary	66.80
Lipton (2004)	1	MD	Estuary	63.98
Londoño Cadavid and Ando (2013)	2	IL	River/stream	38.68
Loomis (1996)	1	WA	River/stream	93.07
Lyke (1993)	2	WI	River and lake	78.75
Matthews et al. (1999)	2	MN	River/stream	21.73
Opaluch et al. (1998)	1	NY	Estuary	138.47
Roberts and Leitch (1997)	1	MN, SD	Lake	8.35
Rowe et al. (1985)	1	CO	River/stream	134.59
Sanders et al. (1990)	4	CO	River/stream	160.69
Schulze et al. (1995)	2	MT	River/stream	20.84
Shrestha and Alavalapati (2004)	2	FL	River and lake	156.46
Stumborg et al. (2001)	2	WI	Lake	84.29
Sutherland and Walsh (1985)	1	MT	River and lake	146.03
Takatsuka (2004)	4	TN	River/stream	286.88
Wattage (1993)	3	IA	River/stream	53.89
Welle (1986)	6	MN	Lake	167.28
Welle and Hodgson (2011)	3	MN	Lake	145.10

Table 1. (continued) Primary Studies in Metadata (mean WTP is per household per year in 2007 USD).

Wey (1990)	2	RI	Salt pond/marsh	147.26
Whitehead and Groothuis (1992)	3	NC	River/stream	41.01
Whitehead (2006)	3	NC	River/stream	187.18
Whitehead et al. (1995)	2	NC	Estuary	95.44
Whittington et al. (1994)	1	TX	Estuary	194.72

†See Appendix D for full citations.

the population affected by the water quality change) and their combined effect on household WTP. Two of the variables, *Ln_AreaRatio1* and *Ln_AreaRatio2*, divide the size of the market area (i.e., the area of the towns, counties, or states where the affected population lives) by the size of the counties that intersect the focal water body or the size of the watershed(s) that surround the focal water body, respectively. The third composite variable (*Ln_RelativeSize*) divides the size of the focal resource, calculated as shoreline length, by the size of the market area. Economic theory provides no intuition as to which composite variable would best explain variation in household WTP, so three separate regression models were estimated.

A trans-log specification, in which the dependent variable and the continuous independent variables (e.g., water quality change, household income, and spatial metrics) appear as natural logs, was used because of its ability to capture curvature in the valuation function and because it constrains the value of WTP to zero as values of those independent variables approach zero.[3] The three specifications described above were tested against a restricted model that omits all three spatial composite variables. The models were estimated using an unweighted generalized least squares (GLS) random-effects procedure with robust standard errors that accounts for cross-sectional correlation among multiple observations from the same primary study.

Regression results are reported in Table 3. Wald chi-square tests reject the null hypothesis that the restricted model is the same as the three unrestricted models, indicating that the spatial composite variables add significant explanatory power. Of the 23 explanatory variables, the majority are statistically significant at the $p < 0.10$ level and most of those, including the three spatial composite variables, are significant at the $p < 0.01$ level. The signs of statistically significant parameter estimates match what one would expect based on economic theory or intuition. For example, household WTP is positively related to the size of the water quality improvement, median household income, the proportion of the focal resource type within an entire state that is improved, and one-time lump-sum (versus annual) payments, while it is negatively related to the proportion of agriculture land in intersecting counties (a non-complementary land use), an affected population of only non-users, and median (versus mean) WTP. All three spatial composite variables are of the appropriate sign. The positive sign on *Ln_RelativeSize* can be interpreted as follows. Starting with the numerator, the larger the size of the improved water body, the higher is per household WTP, *ceteris paribus*. That is, a household is willing to pay more for a similar increase in water quality in a larger lake than in a smaller lake because water quality has been improved over a larger geographical area. Thus, the effect of a larger number in the numerator is positive. Now consider the effect of the

[3] Other advantages of the trans-log functional form are discussed by Johnston et al. 2005.

denominator. The larger the market area (or the area over which people were sampled by each original study in the metadata), the longer the average distance between a given household and the focal water body. People farther away from water bodies are generally willing to pay less to improve those water bodies, compared to otherwise identical people who live closer to the same water bodies. Thus, the larger the market area, the lower the household WTP, *ceteris paribus*. However, because market area is in the *denominator* of the composite variable, larger market areas make the composite variable smaller (an inverse relationship). Thus, the overall effect of relative size on household WTP is positive. Similar logic can be used for the other spatial composite variables, but the sign is negative because market area is in the numerator rather than the denominator.[4]

Table 2. Meta-Analysis Variable Descriptions and Mean Metadata Values.

Variable	Description	Mean
Ln_BaseQuality	Natural log of the baseline water quality from which improvements would occur, specified on the 100-point water quality index.	3.589
Ln_QualityChg	Natural log of the change in water quality, specified on the 100-point water quality index.	2.907
Ln_Income	Natural log of median household income (in 2007 USD) for the market area based on historical U.S. Census data.	10.745
Non_Users	Binary variable indicating that the survey was implemented over a population of nonusers only.	0.086
Swim_Use	Binary variable indicating that changes in swimming uses are specifically noted in the survey.	0.264
Boat_Use	Binary variable indicating that changes in boating uses are specifically noted in the survey.	0.114
Game_Fish	Binary variable indicating that changes in game fishing uses are specifically noted in the survey.	0.057
River	Binary variable indicating that the focal resource is a river or multiple rivers.	0.686
Multi_Body	Binary variable indicating the focal resource includes multiple water body types (e.g., rivers *and* estuaries).	0.078
Ln_PropAgLand	Natural log of the proportion of the land area in all counties that intersect the improved focal resource that is agricultural land based on the National Land Cover Database (NLCD).	-1.433

[4] More details of the entire benefit transfer function generation process can be found in Johnston et al. 2016.

Table 2 (continued) Meta-Analysis Variable Descriptions and Mean Metadata Values.

Variable	Description	Mean
Ln_RelativeSize	Natural log of the total shoreline length (in kilometers) of the improved focal resource divided by the size of the market area (in square kilometers). For a river, shoreline length is given by the two times the length of the river. For a bay, shoreline length is the perimeter of the bay, not including tributaries.	-1.198
ProportionChg	Proportion of water bodies of the same hydrological type as the improved focal resource, within affected state(s). For rivers, this is measured as the length of the improved river divided by the length of all rivers of the same or lower order (*PropChgRiver*). For bays and estuaries, this is defined as the shoreline length of the water body as a proportion of all analogous (e.g., coastal) shoreline lengths (*PropChgBay*). *ProportionChg* is defined as the maximum of *PropChgRiver* or *PropChgBay*.	0.188
Northeast_US	Binary variable indicating that the survey included respondents from the USDA Northeast region.	0.071
Central_US	Binary variable indicating that the survey included respondents from the USDA Midwest or Mountain Plains region.	0.336
Southern_US	Binary variable indicating that the survey included respondents from the USDA Southeast or Southwest.	0.157
MedianWTP	Binary variable indicating that the study's WTP measure is the median rather than the mean.	0.071
LumpSum	Binary variable indicating that payments were to occur on something other than an annual basis over an extended or indefinite period of time.	0.186
Ln_StudyYear	Natural log of the year in which the primary study was conducted (converted to an index by subtracting 1980, before making the log transformation).	2.212
ChoiceExp	Binary variable with a value of one for studies that are choice experiments.	0.107
Thesis	Binary variable with a value of one for studies developed as thesis projects or dissertations.	0.144
Voluntary	Binary variable indicating that WTP was estimated using a payment vehicle described as voluntary.	0.086

Table 2 (continued) Meta-Analysis Variable Descriptions and Mean Metadata Values.

Variable	Description	Mean
NonParametric	Binary variable indicating that WTP was estimated using non-parametric methods.	0.429
NonReviewed	Binary variable indicating that the study was not published in a peer-reviewed journal.	0.236

Table 3. Benefit Transfer Function Coefficients and Standard Errors (SE).

Variable	Model 1	(SE)	Model 2	(SE)	Model 3	(SE)
Ln_BaseQuality	-0.068	(0.122)	-0.064	(0.123)	-0.046	(0.125)
Ln_QualityChg	0.282	(0.106)***	0.281	(0.106)***	0.293	(0.108)***
Ln_Income	0.679	(0.373)*	0.628	(0.375)*	0.618	(0.386)
Non_Users	-0.440	(0.122)***	-0.455	(0.121)***	-0.473	(0.000)***
Swim_Use	-0.395	(0.221)*	-0.391	(0.220)*	-0.385	(0.220)*
Boat_Use	-0.318	(0.171)*	-0.314	(0.183)*	-0.363	(0.171)**
Game_Fish	0.342	(0.194)*	0.303	(0.207)	0.315	(0.206)
River	-0.192	(0.133)	-0.226	(0.128)*	-0.207	(0.129)
Multi_Body	-0.532	(0.140)***	-0.525	(0.145)***	-0.538	(0.132)***
Ln_PropAgLand	-0.347	(0.093)***	-0.351	(0.095)***	-0.337	(0.092)***
Ln_AreaRatio1	-0.072	(0.026)***	------	------	------	------
Ln_AreaRatio2	------	------	------	------	-0.059	(0.022)***
Ln_RelativeSize	------	------	0.052	(0.019)***	------	------
ProportionChg	0.693	(0.194)***	0.525	(0.189)***	0.638	(0.188)***
Northeast_US	0.542	(0.245)**	0.549	(0.249)**	0.530	(0.257)**
Central_US	0.606	(0.108)***	0.601	(0.112)***	0.565	(0.106)***
Southern_US	1.399	(0.133)***	1.366	(0.127)***	1.345	(0.131)***
MedianWTP	-0.288	(0.225)	-0.264	(0.239)	-0.305	(0.220)
LumpSum	0.777	(0.137)***	0.727	(0.136)***	0.747	(0.134)***
Ln_StudyYear	-0.477	(0.080)***	-0.478	(0.080)***	-0.469	(0.080)***

Table 3. Benefit Transfer Function Coefficients and Standard Errors (SE).

Variable	Model 1	(SE)	Model 2	(SE)	Model 3	(SE)
ChoiceExp	0.489	(0.198)**	0.487	(0.210)**	0.469	(0.206)**
Thesis	0.609	(0.196)***	0.557	(0.195)**	0.584	(0.194)***
Voluntary	-1.315	(0.228)***	-1.296	(0.209)***	-1.275	(0.223)***
OutlierBids	-0.421	(0.120)***	-0.429	(0.120)***	-0.428	(0.117)***
NonParametric	-0.499	(0.129)***	-0.477	(0.126)***	-0.516	(0.128)***
NonReviewed	-0.656	(0.165)***	-0.679	(0.171)***	-0.619	(0.172)***
Intercept	-3.030	(4.269)	-2.281	(4.225)	-2.369	(4.256)
R^2	0.63		0.63		0.63	
σ_ε	0.541		0.541		0.541	

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

3. Economic Valuation and the Benefit Transfer Process

The goal of many benefit transfers is to forecast economic values (e.g., household WTP estimates) for specific management activities or policies that have the potential to lead to changes in one or more ecosystem services. In this section, we present a suite of water quality change scenarios and describe the process by which we applied the benefit transfer function estimated in the previous section. We include a description of external data requirements and intermediate calculations, and end the section with a detailed illustration for one scenario.

Scenario Descriptions

Each unique scenario is defined by descriptions of the focal resource, the level of improvement in the quality of that resource, and the market area (i.e., affected human population). For this project, we investigate water-quality change scenarios that focus on three focal water body resources within the Great Bay watershed: the Great Bay Estuary itself, not including tributaries (Figure 1), and the freshwater and tidal portions of one subwatershed, that associated with the Exeter-Squamscott River (Figure 2). The choice of the Exeter-Squamscott River was driven by the appeal of coordinating this economic analysis with work being done by the Buffers Options for the Bay project's Community Assessment group.

For the Great Bay Estuary, we evaluate water quality improvements at three different socio-economic scales (i.e., market areas): (i) residents in N.H. towns immediately adjacent to the bay (Figure 1), (ii) residents of N.H. towns within the entire Great Bay watershed (Figure 3), and (iii) all residents of the state of N.H. While we acknowledge that several towns in Maine are part of the Great Bay watershed and that those residents would have positive WTP for water quality improvements, we focus this analysis on New Hampshire residents only. For the freshwater and tidal portions of the Exeter-Squamscott River, we evaluate willingness to pay for residents in towns adjacent to the upper or lower portion of the river, respectively (Figure 2).

Because biophysical information on specific policy-driven changes in buffer quantity, quality, and location (as well as the associated changes to water quality) was not available for this project, we investigated a range of potential water quality improvements: 3, 5, 7, and 9-point increases on a 100-point water quality index beyond current (i.e., baseline) conditions. We also investigated a set of policy scenarios that consider the potential ramifications of a "do nothing" buffer policy that would lead to a reduction or degradation in the existing supply of vegetated buffers and a subsequent reduction in water quality. For these hypothetical scenarios, we forecast annual household willingness to pay to maintain water quality at its current level rather than allowing it to fall below the minimum WQI threshold required for swimming. We refer to these scenarios as "maintain swimmable" water quality.

The combination of five distinct water body market areas (i.e., affected populations) and five distinct water quality changes results in 25 unique scenarios. For each of these, we conduct sensitivity analysis utilizing minimum and maximum estimates for the current (i.e., baseline) water quality conditions, giving us a total of 50 unique scenarios.

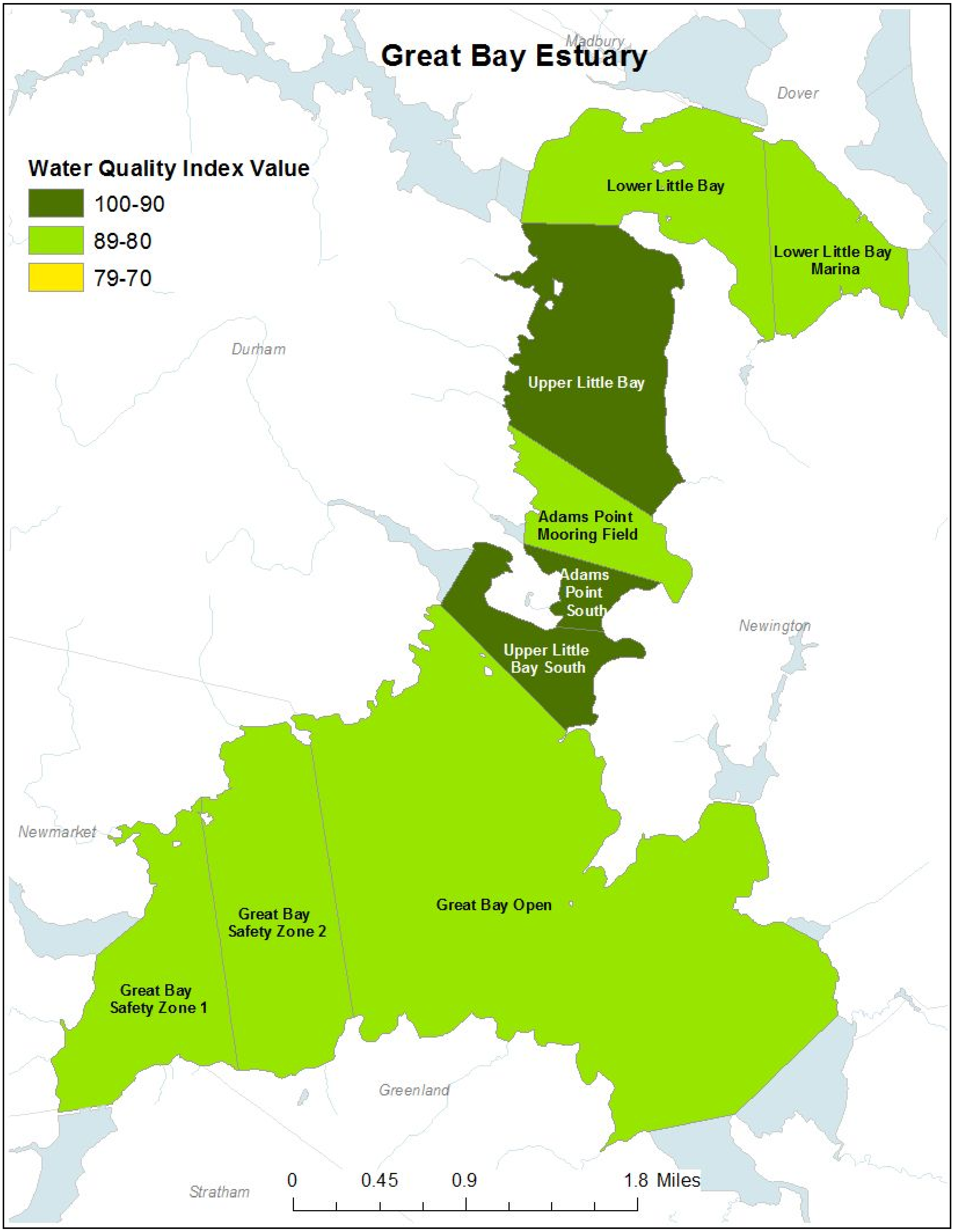


Figure 1. Great Bay Estuary Major Assessment Units and Baseline Water Quality (Table 6). Water Quality Index (WQI) values are calculated using Equation 3.

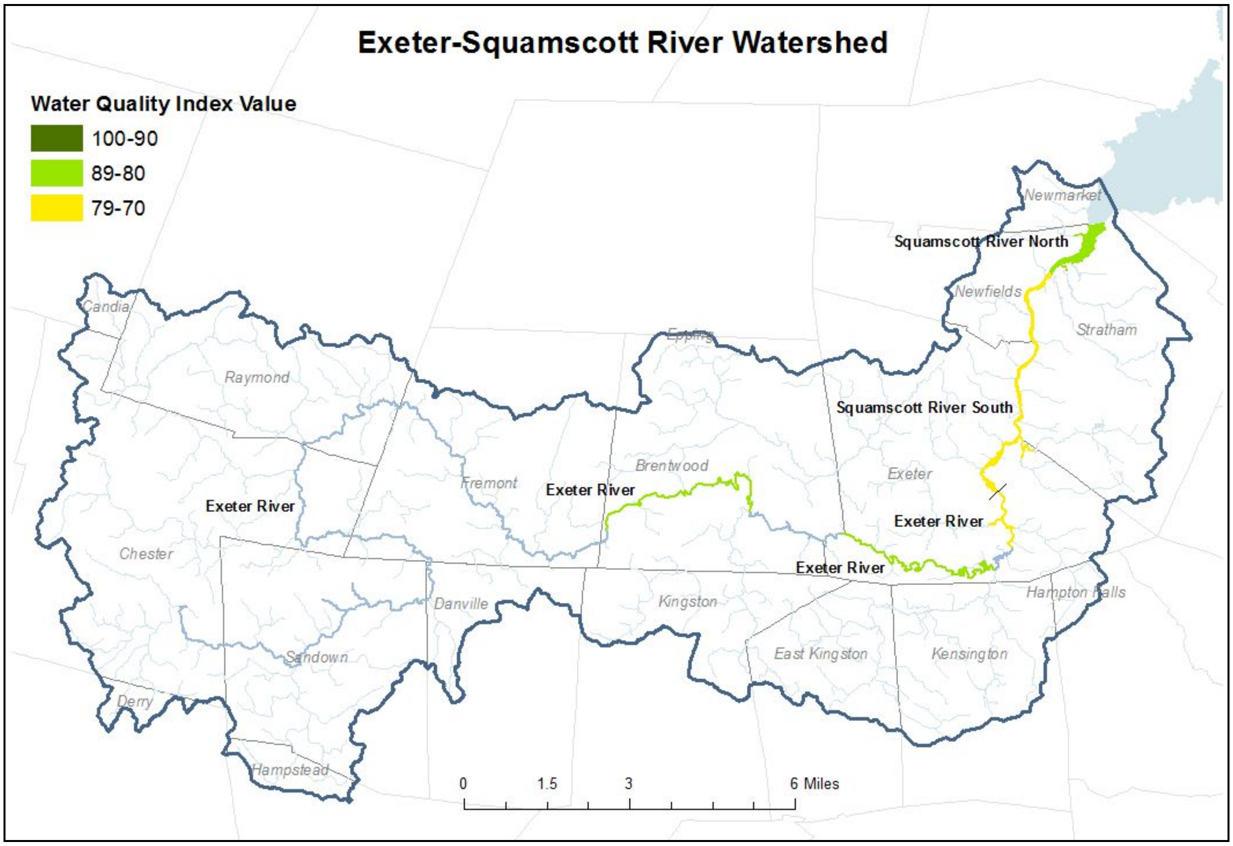


Figure 2. Exeter-Squamscott River Watershed, a sub-watershed in the southern portion of the Great Bay watershed (Hydrologic Unit Code 0106000308). The Exeter River is the freshwater portion of the river from the headwaters to the Exeter town center (indicated by hash mark across river) while the Squamscott River is the tidal portion of the river from the Exeter town center to the Great Bay. Baseline water quality shown for select river segments (Table 6). Water Quality Index (WQI) values are calculated using Equation 3.

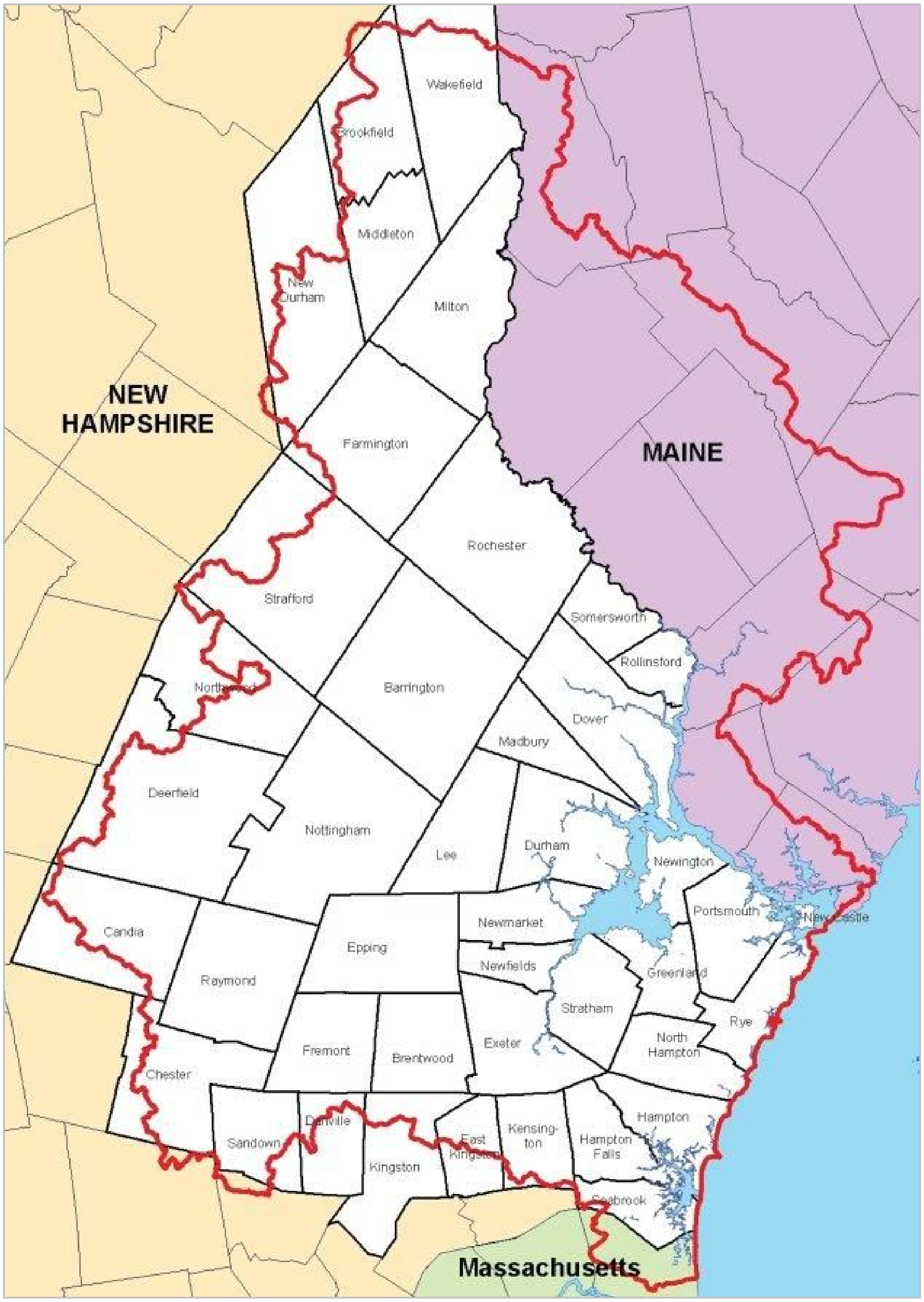


Figure 3. New Hampshire communities in the Great Bay watershed.
(Source: http://info.nhpr.org/sites/default/files/gbmap081610.jpg; downloaded 8/24/16)

Data Requirements and Sources

For each scenario, the benefit transfer process requires values (or levels) to be chosen for each independent variable (Table 2) that are then plugged into Equation 1. Where possible, these variable levels are typically chosen to reflect current conditions at the policy site—or the site for which value estimates are desired. Selecting variable levels in this way enables the resulting WTP estimates to be tailored to specific conditions at the policy site. Some of these values require intermediate calculations using external data such as spatial landscape (GIS) metrics, population census data, and a set of baseline water quality data, while other values are selected based on anticipated policy or management activity contributions or economic fundamentals.

For the geospatial variables (*Ln_PropAgLand*, *Ln_AreaRatio1*, *Ln_AreaRatio2*, *Ln_RelativeSize*, and *ProportionChg*), values of the underlying components (e.g., shoreline length, watershed area, town area, county area, and agricultural land area) are generated using spatial GIS techniques. Benefit transfers are then calculated based on the variable definitions provided in Table 2. For example, *Ln_RelativeSize* is calculated by dividing the shoreline length of the focal resource (river or bay) by the size of the market area and then taking the natural log of the result. Potential sources for raw data include the National Hydrography Dataset (http://www.horizon-systems.com/NHDPlus/NHDPlusV2_home.php), the Hydrologic Unit Code Watershed Boundary Dataset (http://water.usgs.gov/GIS/huc.html), the National Land Cover Database (NLCD) (http://www.mrlc.gov), the NOAA Global Self-Consistent, Hierarchical, High-resolution Geography Database (GSHHD); http://www.ngdc.noaa.gov/mgg/shorelines/shorelines.html), and US Census (http://www.census.gov/geo/maps-data/data/tiger.html).[5]

For the affected population(s), median household income (*Ln_Income*) and number of households for selected towns, counties, and states can be obtained directly from US Census data. We used 2015 households and median household income from the 2011-2015 American Community Survey 5-year Estimates (https://www.census.gov/programs-surveys/acs/). Median household income for the Great Bay watershed was approximated using a household weighted average for Rockingham and Strafford counties. Median household income for groups of communities (e.g., communities adjacent to the Exeter River) were calculated as a household-weighted average across the communities. Because the meta-regression analysis used 2007 US dollars in its estimation process, it is necessary to convert income values from 2015 USD to 2007 USD using the following equation and values for the average monthly Consumer Price Index (CPI) from U.S. Bureau of Labor Statistics (https://www.bls.gov/cpi/):

$$\text{Median Household Income}_{2007} = \text{Median Household Income}_{2015} * (CPI_{2007}/CPI_{2015})$$ [6] (2)

Values for the remaining variables (except baseline water quality) are selected based on the scenario definition. Because none of the scenarios involved multiple geographically distinct water body types, we set *Multi_Body* = 0. The Squamscott and Exeter scenarios include a river,

[5] Geospatial and household data values used in scenarios can be found in Appendix B.
[6] Average monthly CPI values for 2007 and 2015 are 207.342 and 237.017, respectively.

so *River* = 1. In all scenarios, we were interested in forecasting WTP for both users and nonusers (*Non_Users* = 0) in New Hampshire (*Northeast_US* = 1) and the three recreational uses (*Swim_Use* = 1, *Boat_Use* = 1, *Game_Fish* = 1). For the primary study variables, we chose an annual, mandatory, mean payment (*LumpSum* = 0, *Voluntary* = 0, *MedianWTP* = 0), and selected values as if the study occurred in 2017 (*StudyYear* = 2017), omitted outlier bids (*OutlierBids* = 0), and was peer reviewed (*NonReviewed* = 0). We used the mean value of the metadata for the remaining variables.

For the baseline water quality variable (*Ln_BaseQuality*), it is necessary to calculate the value of a 100-point water quality index (WQI) for the focal water body. The WQI provides a single number for describing general water quality that can be related to the suitability of a water body for various human uses (e.g., swimming, fishing, or boating) or to the presence of particular aquatic species. As such, the WQI links specific water quality pollutant levels (e.g., fecal coliform concentrations) to particular human use and non-use benefits. Our analysis uses the WQI methodology and classification of United State Environmental Protection Agency (USEPA) (2009), adapted from the Oregon Water Quality Index of Cude (2001), because of its national scope and support of rivers, streams, *and* estuaries.

Implementing the WQI for a particular water body entails three steps: (1) obtaining pollutant data for the water body of interest, (2) transforming these data into sub index values, and (3) combining the subindex values into an aggregate water quality index. The specific water quality pollutants used by the WQI, along with their required units of measure and associated WQI subindex weights, are shown in Table 4. Pollutant data was obtained from the New Hampshire Department of Environmental Services (NHDES). These data were averaged across all sampling periods and monitoring stations for several NHDES Water Quality Assessment Units in each our three focal water bodies (Table 6) to produce WQI pollutant parameter values for each pollutant subindex.[7] We elected to investigate water quality in each Assessment Unit rather than averaging pollutant data across the entire water body in order to produce a range of water quality values that could then be assessed in sensitivity analyses. These pollutant parameter values were then transformed into the corresponding subindex values using the information in Table 5, which is derived from USEPA (2009, Tables 10-1 and 10-3 and Appendix F). There are six water quality subindices in each WQI, however, note that the WQI for freshwater rivers and streams includes biochemical oxygen demand (BOD), while the WQI for estuaries includes chlorophyll-*a* (ChA). Finally, the subindex values and subindex weights were used to calculate the WQI for each major water body using the following (weighted geometric mean) equation:

$$WQI = \prod_{i=1}^{6} Q_i^{W_i} \qquad (3)$$

where Q_i is the calculated water quality subindex for parameter i and W_i is the weight of the ith parameter from Table 4. Calculated baseline WQI values for each water quality assessment unit are shown in the last column of Table 6.

[7] Average pollutant concentration values for each assessment unit used in our scenarios are listed in Appendix C.

Table 4. Water Quality Index (WQI) Pollutants, Concentration Units, and Index Weights.

Pollutant	Unit	Freshwater WQI Weight	Estuarine WQI Weight
Dissolved Oxygen (DO)	Mg/L	0.24	0.26
Fecal Coliform (FC)	colonies/100mL	0.22	0.25
Total Nitrogen (TN)	Mg/L	0.14	0.15
Total Phosphorous (TP)	Mg/L	0.14	0.15
Total Suspended Solids (TSS)	Mg/L	0.11	0.11
Biochemical Oxygen Demand (BOD)	Mg/L	0.15	---
Chlorophyll-*a* (ChA)	µg/L	---	0.08

Table 5. Water Quality Index Parameter-Subindex Transformation Equations.

Parameter	Value	Subindex
DO	$DO \le 3.3$	10
	$3.3 < DO < 10.5$	$-80.29 + 31.88*DO – 1.401*DO^2$
	$10.5 \le DO$	100
FC	$FC \le 50$	98
	$50 < FC \le 1600$	98 * exp(-0.00099178*(FC – 50))
	$1600 < FC$	10
TN	$TN \le 3$	100 * exp(-0.4605*TN)
	$3 < TN$	10
TP	$TP \le 0.25$	$100 – 299.5*TP – 0.1384*TP^2$
	$0.25 < TP$	10
TSS	$TSS \le 28$	100
	$28 < TSS \le 168$	158.48 * exp(-0.0164*TSS)
	$168 < TSS$	10
BOD	$BOD \le 8$	100 * exp(-0.1993*BOD)
	$8 < BOD$	10
ChA	$ChA \le 40$	100 * exp(-0.05605*ChA)
	$40 < ChA$	10

Table 6. Major Water Bodies Used in Scenarios and Baseline Water Quality.

Water Body	NHDES Assessment Unit (ID)	Type	Baseline WQI
Exeter River*	Exeter River – Brentwood (NHRIV600030803-05)	River/Stream	85
Exeter River*	Exeter River – Exeter (NHRIV600030805-02)	River/Stream	84
Exeter River*	Exeter River – Exeter Dam (NHIMP600030805-04)**	Impoundment	77
Squamscott River	Squamscott River South (NHEST600030806-01-01)	Estuary	71
Squamscott River	Squamscott River North (NHEST600030806-01-02)	Estuary	86
Great Bay	Great Bay Safety Zone 1 (NHEST600030904-02)	Estuary	87
Great Bay	Great Bay Safety Zone 2 (NHEST600030904-03)	Estuary	85
Great Bay	Great Bay Open (NHEST600030904-04-05)	Estuary	89
Great Bay	Adams Point South (NHEST600030904-04-06)	Estuary	92
Great Bay	Upper Little Bay South (NHEST600030904-06-12)	Estuary	93
Great Bay	Adams Point Mooring Field (NHEST600030904-06-10)	Estuary	84
Great Bay	Upper Little Bay (NHEST600030904-06-19)	Estuary	91
Great Bay	Lower Little Bay (NHEST600030904-06-18)	Estuary	88
Great Bay	Lower Little Bay Marina (NHEST600030904-06-14)	Estuary	89

* Water quality data was limited for much of the Exeter River. The "Brentwood" assessment unit was the farthest upstream unit that contained a relatively complete set of pollutant data.

** Beginning in 2016, impoundment area NHIMP600030805-04 behind the Exeter River dam became part of river area NHRIV600030805-32.

Table 7. Water Quality Classifications (USEPA 2009).

WQI Value	Water Quality Classification
95	Drinking without treatment
70	Swimming
50	Game fishing (food)
45	Rough fishing (non-food)
25	Boating

The WQI can be used to describe general water quality and is useful for making comparisons among water bodies at a given time, assessing changes in water quality for a particular water body over time, or assisting with management decision making. A water quality classification system can facilitate this process. USEPA's (2009) water quality classification identifies the minimum WQI value on a 100-point scale required for particular human uses (Table 7). These classes were originally determined by assessing the minimum threshold level of each WQI pollutant that would be required to be met for each human use. However, there is no guarantee that a specific occurrence of this value means that the water body supports the particular use. For example, a WQI value of 70 is the minimum value necessary for swimming (i.e., contact recreation). However, a WQI value of 70 does not guarantee that a particular water body is of good enough quality for swimming as it possible that one of the index pollutants relatively less important for swimming (e.g., dissolved oxygen) is above its minimum threshold while another index pollutant relatively more important for swimming (chlorophyll-*a*) is below its minimum threshold. Another consideration is the importance of pollutants that are omitted from the WQI. For example, relatively high concentrations of mercury in the water body would prohibit fish consumption even if the value of the WQI, which does not include mercury, was very high. In fact, mercury levels are high throughout the Great Bay watershed. Thus, the water quality classifications in Table 4 can "aid in the assessment of water quality for general recreational uses" but they "cannot determine the quality of water for specific uses" (Cude 2001, p. 126).

Water quality varies among our study's assessment units (Table 6, Figures 2 and 3). While none of the water bodies investigated here are suitable for drinking without treatment (i.e., all have a WQI < 95), the nine assessment units of the Great Bay (an area-weighted WQI of 88), the northern portion of the Squamscott River (section closest to the bay), and most of the Exeter River are suitable for boating, fishing and swimming uses (Tables 6 and 7). Thus, it appears as though the Great Bay itself has been able to assimilate or dilute pollutant loads from contributing rivers. In contrast, the southern portion of the Squamscott River (closer to Exeter town center) and the portion of the Exeter River behind the Exeter dam are barely suitable for swimming (based on WQI scores) and may be focal areas for future policy or management interventions. What is most noticeable about the water quality pollutants in Squamscott River South is the high level of chlorophyll-a, 42.8μg/L (Appendix C). In comparison, other values throughout the study region range from 1.5μg/L in the Lower Little Bay Marina to 8.1μg/L in Squamscott River North. Fecal coliform levels in Squamscott River South are also the highest in the study region (Appendix C).

Benefit Transfer Illustration

Once all the levels for the independent variables are chosen for a given scenario, they can be plugged into Equation 1, which gives a value for ln (WTP), or the natural log of per household WTP. To obtain an estimate of mean per household WTP, it is necessary to use the following exponential transformation:

$$WTP = \exp(\ln WTP + \sigma_{\varepsilon}^{2}/2) \qquad (3)$$

where σ_{ε} is the model error variance from Table 3. Note that the value of WTP that comes out of this analysis is in 2007 US dollars and can be converted to current dollars using values from the CPI similar to the process used to convert median household income from 2015 USD to 2007 USD in Equation 2.

The benefit transfer process described in the previous sections is illustrated in Table 8 for the Squamscott River 9-point WQI increase scenario, using Model 2 of the benefit transfer function (Table 3) and the lower bound of baseline water quality for the river (Table 6). Communities in this region include Exeter, Newfields, and Stratham, with a median household income of $86,305 (Appendix B). Given these conditions, the benefit transfer projects annual household WTP = $53.73 (2016 USD). This reflects the amount of money that an average household in these communities would be willing to pay, in order to increase water quality from its current WQI level of 71 to 80. When aggregated across all households in the three adjacent communities, the result is a total WTP of $4.64 million per year. All subsequent analyses also use Model 2 of the benefit transfer function.

Table 8. Illustrating the benefit transfer process for a 9-point increase on the 100-point water quality index (WQI) in the Squamscott River (baseline WQI is 71).

Variable	(A) Model Coefficients	(B) Selected Values	Data Source	(C) Product (A) * (B)
Ln_BaseQuality	-0.064	4.260	NHDES	-0.273
Ln_QualityChg	0.281	3.185	Scenario	0.617
Ln_Income	0.628	11.232	U.S. Census	7.054
Non_Users	-0.455	0	Scenario	0.000
Swim_Use	-0.391	1	Scenario	-0.391
Boat_Use	-0.314	1	Scenario	-0.314
Game_Fish	0.303	1	Scenario	0.303
River	-0.226	1	Scenario	-0.226
Multi_Body	-0.525	0	Scenario	0.000
Ln_PropAgLand	-0.351	-2.795	GIS calculated	0.981
Ln_RelativeSize	0.052	-1.704	GIS calculated	-0.089
ProportionChg	0.525	0.008	GIS calculated	0.004
Northeast_US	0.549	1	Scenario	0.549
Central_US	0.601	0	Scenario	0.000
Southern_US	1.366	0	Scenario	0.000
MedianWTP	-0.264	0	Scenario	0.000
LumpSum	0.727	0	Scenario	0.000
Ln_StudyYear	-0.478	3.611	Scenario	-1.726
ChoiceExp	0.487	0.107	Metadata	0.052
Thesis	0.557	0.114	Metadata	0.063
Voluntary	-1.296	0	Scenario	0.000
OutlierBids	-0.429	1	Scenario	-0.429
NonParametric	-0.477	0.429	Metadata	-0.205
NonReviewed	-0.679	0	Scenario	0.000
Intercept	-2.281	1		-2.281

Calculation	Data	Result	Value
sum of column (C)		lnWTP	3.691
exp(lnWTP + $\sigma_\varepsilon^2/2$)	σ_ε = 0.541	Household WTP_{2007}	46.41
$(CPI_{2016}/CPI_{2007})*WTP_{07}$	CPI_{2007} = 207.342 CPI_{2016} = 240.007	**Household WTP_{2016}**	53.73
WTP * #Households	#Households = 9637	**Regionwide WTP**	4,636,788

5. Water Quality Values for New Hampshire's Great Bay

The benefit transfer produces a wide range of willingness to pay forecasts for water quality improvements in New Hampshire's Great Bay watershed, with results varying as expected over the 50 unique scenarios (Figures 4 through 6, Table 9). As shown by these scenarios, multiple factors can cause WTP to either increase or decrease. For example, annual household WTP increases as the size of the water quality improvement increases (e.g., from a 3-point increase to a 9-point increase) for all focal water bodies (Figure 4). For the Exeter-Squamscott River, WTP values range from $39 to $54 per household per year, for households in adjacent communities along both freshwater and tidal areas of the river. While the baseline water quality is better and the size of the improved water body (i.e., the length of the river) is larger in the Exeter (freshwater) portion of the river, median household income is higher in the Squamscott (tidal) portion (Table 6, Appendix B). Thus, despite differences in scenario parameters, tradeoffs among those parameters can result in similar WTP forecasts. Annual household WTP is greater ($62-$85) for improvements to the entire Great Bay versus the smaller Exeter-Squamscott regions (Figure 4), despite baseline water quality being better and median household income being lower. This is due to the larger size of the improved water body and also due to the relative lack of a substitute for the Great Bay within New Hampshire (Table 6, Appendix B). As the market area for the Great Bay increases from adjacent towns to surrounding counties to the entire state of N.H., annual per household WTP decreases. This reflects a pattern in which people who live farther away value improvements to the Great Bay less than those living closer, *ceteris paribus* (Figure 4). Sensitivity analysis comparing the upper and lower bounds on the calculated baseline WQI indicate household WTP values and trends are robust to variations in baseline water quality throughout the Great Bay watershed (Appendix A, Table A1).

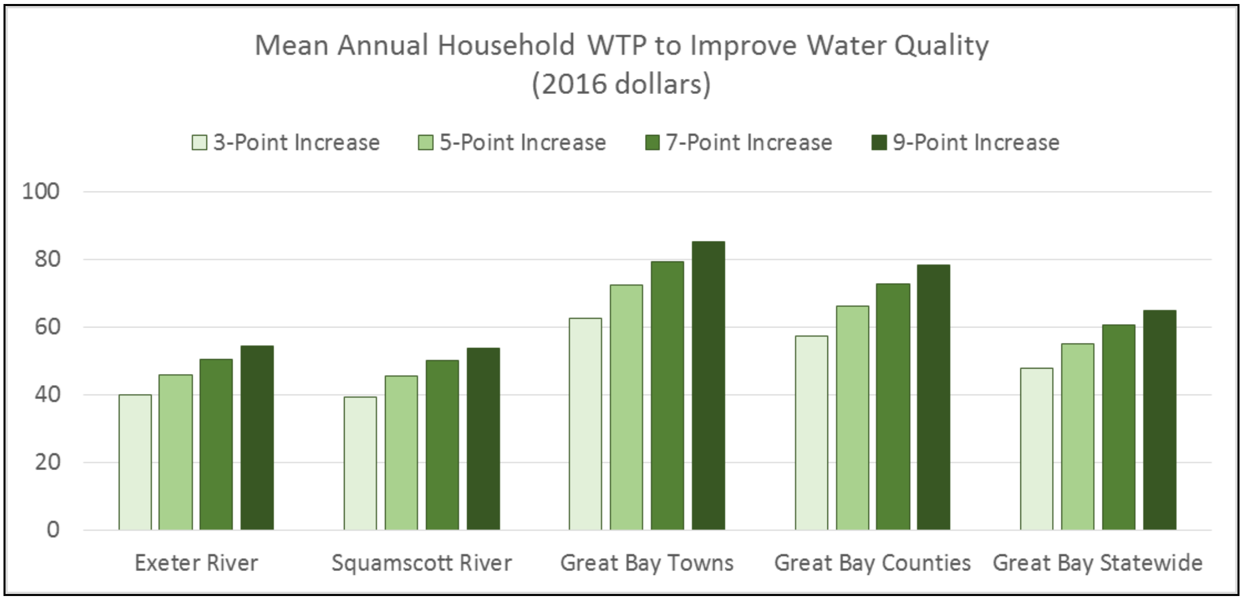


Figure 4. Willingness to pay (per household per year) for 3, 5, 7, and 9-point increases in water quality on the 100-point water quality index (WQI) for three water bodies using the minimum baseline WQI index value for each water body from Table 5. Three market regions (adjacent towns, two counties, and all of N.H.) were assessed for the Great Bay.

Results from the "Maintain Swimmable" scenarios, which forecast willingness to pay to maintain water quality at its current baseline level rather than allowing it to fall below 70 on the 100-point WQI, are also intuitive (Figure 5). Recall that 70 is the minimum threshold value on the WQI that indicates swimming (i.e., direct contact recreation) is an allowable use. In these scenarios, we are considering the potential degradation that could occur without any buffer policy or management interventions. That is, these scenarios represent WTP for damage avoidance. Households are willing to pay more to maintain a higher baseline water quality level (Maximum WQI versus Minimum WQI) across all water bodies, which is best illustrated by the Squamscott River scenarios where the difference between the minimum and maximum baseline of 15 points on the 100-point WQI scale leads to a *difference* in WTP of $35 per household per year. The previous trends associated with larger water bodies (bay versus river) and larger market areas (state versus counties versus adjacent communities) still hold.

WTP aggregated over an entire market area (or population) can vary due to differences in per household WTP, or due to differences in the number of households in the market area. Despite comparable household WTP measures, regional WTP values aggregated across all households in the adjacent communities for the three-town Squamscott (tidal) region are much lower than values for the larger seven-town Exeter (freshwater) region due to the larger number of households in the Exeter region (Figure 6A, Table 9). Aggregated values for the seven communities immediately adjacent to the Great Bay exceed those of the Exeter-Squamscott River, due to both larger household WTP values (because of the larger water body) and the larger number of households (Figure 6A, Table 9). Further, despite lower per household WTP values for the larger market regions, the much larger number of households in the two counties and the entire state results in dramatically higher aggregate regional WTP values (Figure 6B, Table 9). A full set of benefit transfer results, including a comparative analysis of Models 1 and 3, can be found in Appendix A. General trends among the three transfer functions are similar.

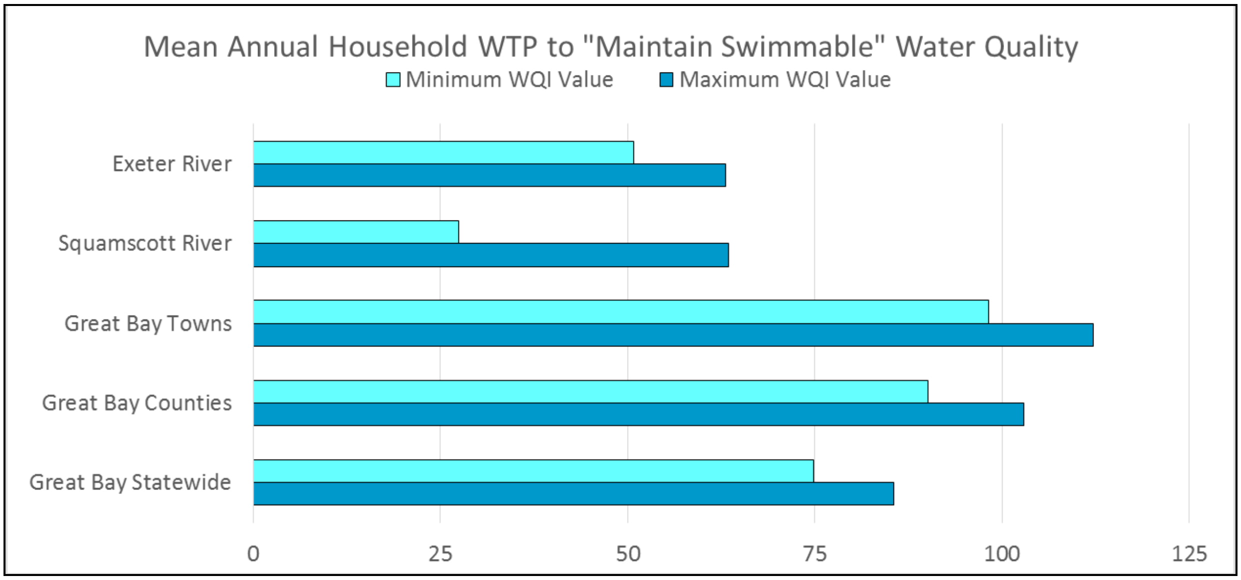
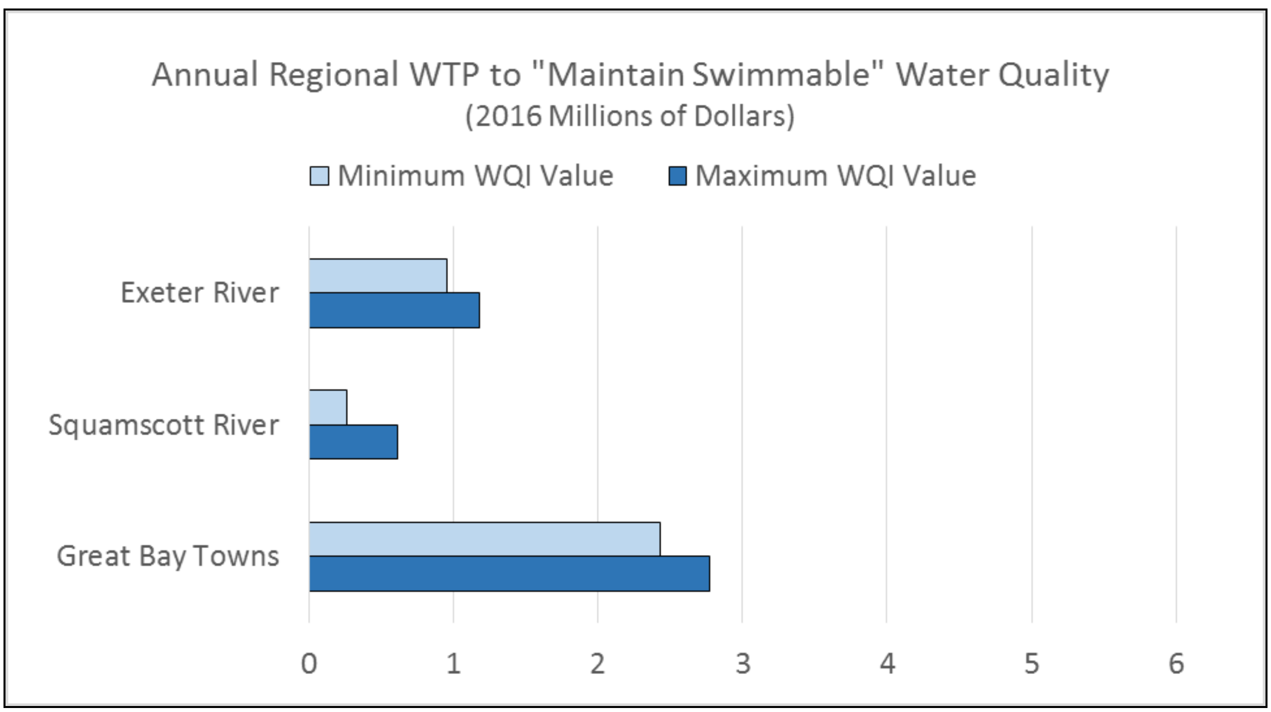


Figure 5. Willingness to pay (per household per year) to maintain water quality at its current baseline level rather than allowing it to fall below 70 on the 100-point water quality index. Three market regions (adjacent towns, two counties, and all of N.H.) were assessed for the Great Bay.

(A)



(B)

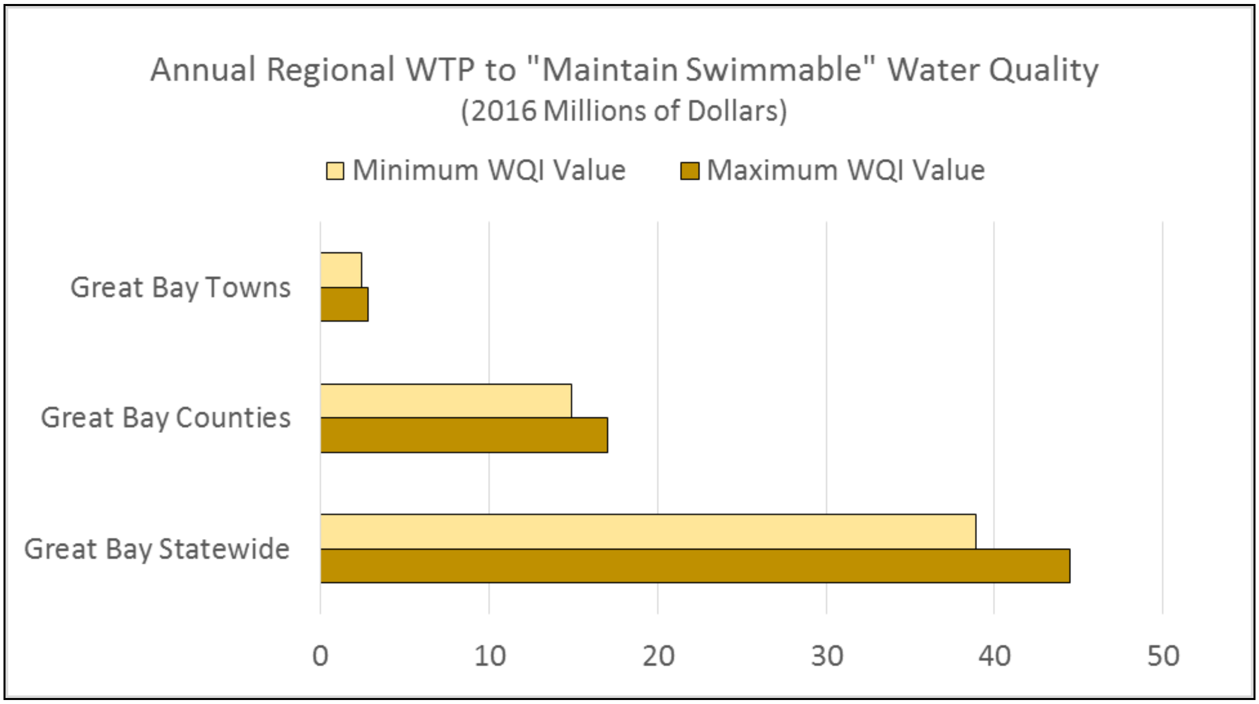


Figure 6. Regional willingness to pay to maintain water quality at its current baseline level rather than allowing it to fall below 70 on the 100-point water quality index. **(A)** Adjacent communities for three water bodies. **(B)** Three market regions for the Great Bay.

Table 9. Annual Regional Willingness to Pay ($ millions) to "Maintain Swimmable" or to Improve Water Quality from the Current Baseline Water Quality Index (WQI) Value.*

Region	Maintain Swimmable	3-point	5-point	7-point	9-point
Exeter River Min	0.95	0.75	0.86	0.95	1.02
Exeter River Max	1.18	0.74	0.86	0.94	1.01
Squamscott River Min	0.27	0.38	0.44	0.48	0.52
Squamscott River Max	0.61	0.38	0.43	0.48	0.51
Great Bay Towns Min	2.43	1.55	1.79	1.97	2.11
Great Bay Towns Max	2.77	1.54	1.78	1.95	2.10
Great Bay Counties Min	14.92	9.52	10.99	12.08	12.97
Great Bay Counties Max	17.05	9.46	10.92	12.01	12.89
Great Bay Statewide Min	38.93	24.85	28.69	31.53	33.84
Great Bay Statewide Max	44.49	24.70	28.51	31.34	33.63

* All values are in 2016 dollars. Swimmable = maintaining water quality at the current baseline level rather than allowing it to fall below 70 on the 100-point WQI.

Using Willingness to Pay (WTP) Values in Decision Making

Results from the benefit transfer approximate WTP estimates that would emerge from a primary stated preference survey conducted over the same market area (e.g., town, county, state). Often these surveys are written such that WTP is elicited from respondents using a referendum question. These questions ask whether surveyed households (respondents) would vote for or against a policy that would improve ecosystem services in a particular way (in a particular region), given a specified cost (e.g., in increases taxes or fees) that varies across different households receiving the survey. Households' votes at different costs illustrate their willingness to exchange money for specified ecosystem service improvements—this is the basis of WTP estimation.

To illustrate how one could use the WTP values described in the previous section and reported in Table 9 and Appendix A, consider the situation of the southern portion of the Squamscott River, which currently has the lowest average water quality in this project's study area. The results of the benefit transfer indicate that residents of the surrounding communities (Exeter, Newfields, and Stratham) would be willing to pay an aggregate amount of $518,000 per year for a 9-point water quality improvement from the current baseline WQI value of 71 to a WQI value of 80. This result implies that the three towns would be able to generate a water quality improvement fund of $518,000 per year through a referendum process. Recall that the Squamscott River's relatively poor water quality is due to high levels of chlorophyll-*a* and fecal coliform compared to other water bodies in the study region. Thus, the three towns could use these funds to target mitigation activities on reducing one or both of these two pollutants. For example, one way of increasing the WQI value to 80 would be to reduce chlorophyll-*a* concentrations from the current level of 43µg/L to 14µg/L; another way would be to reduce chlorophyll-*a* concentrations to 24µg/L while also reducing fecal coliform concentrations from the current level of 233 colonies/100ml to 50 colonies/100ml.

While we elected to include statewide scenarios in our analysis to show how WTP values can change over larger market areas (i.e., larger market areas produce lower household WTP, but much higher aggregate regional WTP), it is unclear whether any statewide buffer policy would focus on the Great Bay estuary alone. It is more likely that a statewide buffer policy would be implemented across all water bodies in the state. Thus, the more relevant aggregate WTP comparison would be among adjacent communities ($1.5-2.8 million) and the two counties that encompass the entire watershed ($9.5-17.1 million). The larger two-county values would be useful for funding buffer polices or management activities that impact the Great Bay and all its tributaries, while the small adjacent community values would be more appropriate for small bay shoreline projects.

It is also important to keep in mind that the WQI is a measure of general water quality, but the human use classifications (e.g., swimming, fishing, boating) cannot be used literally in specific situations. Mercury is prevalent throughout the Great Bay watershed and, thus, practitioners should rely on the NHDES water quality assessment reports (303(d) list) rather than WQI values for human use decisions in specific water bodies.

Interpretation of all the forecasted (i.e., transferred) values should be handled with caution. Results are not exact, but rather approximations of public values for water quality improvements that can be used to guide resource management and policy decision making. It is important to recognize that the values are representative of what households would be willing to pay for particular water quality improvements, but there is no guarantee that those funds would actually be sufficient to support the level of buffer restoration or other activities that actually improves water quality by the desired amount. Consider the Squamscott River case presented above. The economic analysis presented here does not determine whether $518,000 worth of management activities each year would actually achieve a 9-point water quality increase and then maintain that level of water quality into the future. Of course, the opposite could be true as well—funds equaling aggregated WTP might support management activities that exceed the desired level of water quality improvement. That is, WTP reflects the *value* of an improvement to people, not the *cost* of obtaining those improvements.

Quantitatively linking the change in the quantity or quality of buffers that would result from a specific management action to a direct consequential change in the WQI is challenging and beyond the scope of this analysis. As such, this economic analysis forecasts values for water quality improvements directly, and then systematically explores a range of modest changes in water quality from the WQI baseline for each focal resource. The role and potential contribution of buffers in driving changes in water quality of this magnitude can then be explained after the fact, lessoning potential criticism that our modeled scenarios are based on too many biophysical assumptions (e.g., that a buffer of a particular type and location would lead to a particular water quality improvement). The WQI information provided can point practitioners to particular pollutants and could be a good place to start when identifying potential buffer actions, however, it is ultimately necessary to integrate the economic valuation results presented here with the results of biophysical water quality modeling scenarios in order to make well-informed decisions.

Finally, this economic valuation does not inform the decision maker regarding which set of management activities to engage in; that is, there is no cost analysis of buffer management. This analysis quantifies benefits only. A full cost-benefit analysis is often required to determine whether the benefits of specific management actions exceed the costs, although in some cases it may be obvious that the benefits reported here will outweigh the costs without conducting a formal cost analysis.

6. Conclusions

This report describes the generation of a water quality benefit transfer function using meta-analysis techniques, explains the step-by-step process to apply this transfer function to specific management or policy settings (with sufficient detail such that the benefit transfer function can also be used by stakeholders after the Buffer Options for the Bay project ends), and presents economic value forecasts for selected water quality scenarios for the Great Bay. Economic values for water quality improvements in the Great Bay watershed are substantial, ranging from the hundreds of thousands of dollars for small affected populations immediately adjacent to the Exeter-Squamscott River, up to $34 million when values are aggregated over all New Hampshire residents. Even higher economic values exist for maintaining water quality at its current level rather than allowing it to fall below 70 on the WQI, the minimum threshold for swimming uses. The goal of the Buffer Options for the Bay project is "to enhance stakeholder capacity to make informed decisions related to the protection and restoration of buffers around New Hampshire's Great Bay." This report provides economic WTP values for water quality improvements and damage avoidance that can be combined with information from biophysical, hydrological modeling and cost assessments to facilitate well-informed buffer management that recognizes both the costs and benefits of potential actions.

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Appendix A. WTP Comparison across Benefit Transfer Functions.

Table A1. Annual Household WTP Using Three Benefit Transfer Functions.*

Model 1	**Swimmable**	**3-point**	**5-point**	**7-point**	**9-point**
Exeter River Min	52.98	41.59	48.04	52.82	56.70
Exeter River Max	65.84	41.31	47.71	52.46	56.32
Squamscott River Min	32.14	46.16	53.31	58.61	62.92
Squamscott River Max	74.47	45.54	52.59	57.83	62.08
Great Bay Towns Min	118.29	75.34	87.01	95.67	102.70
Great Bay Towns Max	135.24	74.84	86.44	95.04	102.02
Great Bay Counties Min	104.04	66.26	76.53	84.15	90.33
Great Bay Counties Max	118.95	65.82	76.02	83.59	89.73
Great Bay Statewide Min	82.29	52.41	60.53	66.55	71.44
Great Bay Statewide Max	94.08	52.06	60.13	66.11	70.97

Model 2	**Swimmable**	**3-point**	**5-point**	**7-point**	**9-point**
Exeter River Min	50.83	39.95	46.12	50.69	54.40
Exeter River Max	63.12	39.70	45.83	50.37	54.06
Squamscott River Min	27.51	39.46	45.55	50.06	53.73
Squamscott River Max	63.55	38.96	44.97	49.43	53.05
Great Bay Towns Min	98.20	62.69	72.36	79.54	85.36
Great Bay Towns Max	112.22	62.30	71.91	79.04	84.83
Great Bay Counties Min	90.12	57.53	66.41	73.00	78.34
Great Bay Counties Max	102.98	57.17	66.00	72.54	77.85
Great Bay Statewide Min	74.83	47.77	55.14	60.61	65.05
Great Bay Statewide Max	85.51	47.47	54.80	60.23	64.64

Model 3	**Swimmable**	**3-point**	**5-point**	**7-point**	**9-point**
Exeter River Min	46.06	35.91	41.71	46.03	49.54
Exeter River Max	57.73	35.74	41.52	45.82	49.32
Squamscott River Min	26.85	39.12	45.43	50.14	53.97
Squamscott River Max	64.28	38.76	45.02	49.68	53.48
Great Bay Towns Min	106.65	67.05	77.87	85.94	92.50
Great Bay Towns Max	122.57	66.74	77.52	85.55	92.09
Great Bay Counties Min	96.30	60.54	70.31	77.60	83.53
Great Bay Counties Max	110.67	60.27	70.00	77.25	83.15
Great Bay Statewide Min	78.87	49.58	57.59	63.55	68.41
Great Bay Statewide Max	90.65	49.36	57.33	63.27	68.10

* All values are in 2016 dollars. Swimmable = maintaining water quality at the current baseline level rather than allowing it to fall below 70 on the 100-point WQI.

Table A2. Annual Regional WTP ($ millions) Using Three Benefit Transfer Functions.*

Model 1	Swimmable	3-point	5-point	7-point	9-point
Exeter River Min	0.99	0.78	0.90	0.99	1.06
Exeter River Max	1.23	0.77	0.89	0.98	1.05
Squamscott River Min	0.31	0.44	0.51	0.56	0.61
Squamscott River Max	0.72	0.44	0.51	0.56	0.60
Great Bay Towns Min	2.92	1.86	2.15	2.36	2.54
Great Bay Towns Max	3.34	1.85	2.14	2.35	2.52
Great Bay Counties Min	17.22	10.97	12.67	13.93	14.95
Great Bay Counties Max	19.69	10.89	12.58	13.84	14.85
Great Bay Statewide Min	42.81	27.27	31.49	34.62	37.17
Great Bay Statewide Max	48.94	27.09	31.28	34.40	36.92

Model 2	Swimmable	3-point	5-point	7-point	9-point
Exeter River Min	0.95	0.75	0.86	0.95	1.02
Exeter River Max	1.18	0.74	0.86	0.94	1.01
Squamscott River Min	0.27	0.38	0.44	0.48	0.52
Squamscott River Max	0.61	0.38	0.43	0.48	0.51
Great Bay Towns Min	2.43	1.55	1.79	1.97	2.11
Great Bay Towns Max	2.77	1.54	1.78	1.95	2.10
Great Bay Counties Min	14.92	9.52	10.99	12.08	12.97
Great Bay Counties Max	17.05	9.46	10.92	12.01	12.89
Great Bay Statewide Min	38.93	24.85	28.69	31.53	33.84
Great Bay Statewide Max	44.49	24.70	28.51	31.34	33.63

Model 3	Swimmable	3-point	5-point	7-point	9-point
Exeter River Min	0.86	0.67	0.78	0.86	0.93
Exeter River Max	1.08	0.67	0.78	0.86	0.92
Squamscott River Min	0.26	0.38	0.44	0.48	0.52
Squamscott River Max	0.62	0.37	0.43	0.48	0.52
Great Bay Towns Min	2.64	1.66	1.92	2.12	2.29
Great Bay Towns Max	3.03	1.65	1.92	2.11	2.28
Great Bay Counties Min	15.94	10.02	11.64	12.84	13.82
Great Bay Counties Max	18.32	9.97	11.59	12.79	13.76
Great Bay Statewide Min	41.03	25.80	29.96	33.06	35.59
Great Bay Statewide Max	47.16	25.68	29.83	32.92	35.43

* All values are in 2016 millions of dollars. Swimmable = maintaining water quality at the current baseline level rather than allowing it to fall below 70 on the 100-point WQI.

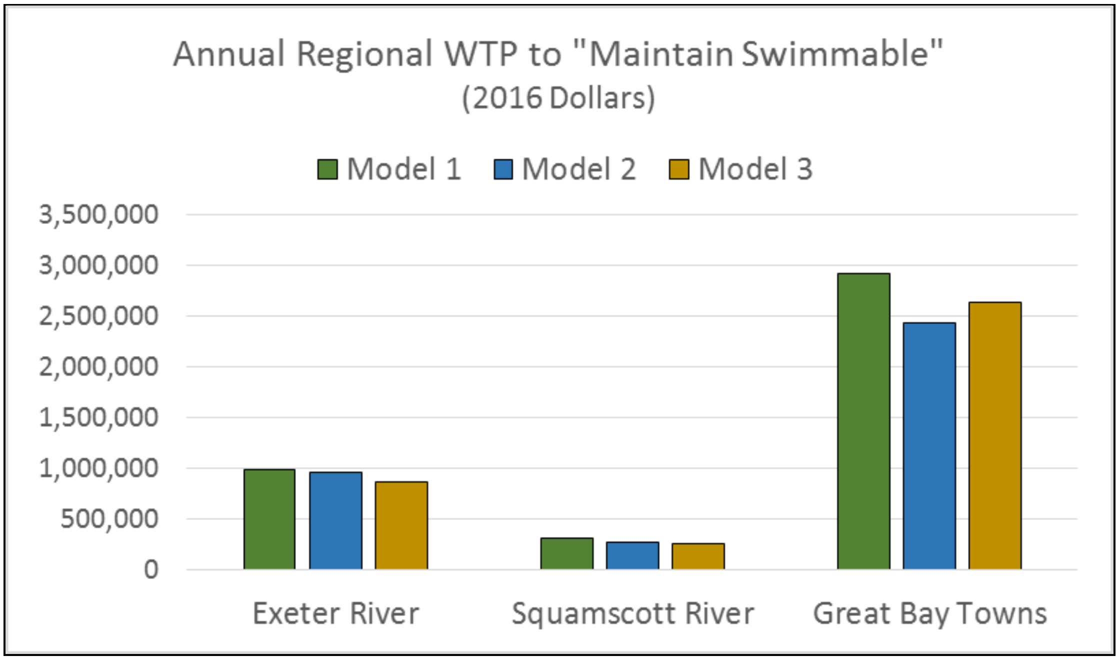

Figure A1. Annual regional willingness to pay to maintain water quality at its current baseline level rather than allowing it to fall below 70 on the 100-point water quality index comparing three models of the benefit transfer function given in Table 3.

Appendix B. Geospatial and Socioeconomic Data Values Used in Benefit Transfer Scenarios.

Variable	**Units**	**Exeter River**	**Squamscott River**	**Great Bay Towns**	**Great Bay Counties**	**Great Bay Statewide**
Market Area Towns/Counties		Brentwood, Chester, Danville, Exeter, Fremont, Raymond, and Sandown	Exeter, Newfields, and Stratham	Dover, Durham, Greenland, Newfields, Newington, Newmarket, and Stratham	Rockingham and Strafford	All N.H. towns
Number of Households	households	18,705	9,637	24,713	165,514	520,251
Household-weighted Median Income	2015 USD	80,724	86,305	71,668	75,329	66,799
Adjusted Median Income	2007 USD	70,617	75,499	62,695	65,898	58,436
Focal River Length	kilometers	65.3	10.1	N/A	N/A	N/A
Focal Shore Length	kilometers	130.6	20.2	61.3	61.3	61.3
Other River Length	kilometers	1191	1191	N/A	N/A	N/A
Other Shore Length	kilometers	2382	2382	24.7	24.7	24.7
Market Area	square-km	353	111	302	2873	24040
County Area	square-km	1882	1882	2873	2873	2873
County Ag Land Area	square-km	115	115	181	181	181
HUC 10 Area	square-km	331	331	1172	1172	1172
HUC 10 Ag Land Area	square-km	38	38	95	95	95

Appendix C. Average Water Quality Pollutant Concentrations Used in WQI Calculations.

	Dissolved Oxygen	Fecal Coliform	Total Nitrogen	Total Phosphorus	BOD or Chloroph yl l-*a*
Exeter River – Brentwood* (NHRIV600030803-05)	7.5956	85.1235	0.5907	0.0203	10.0000
Exeter River – Exeter* (NHRIV600030805-02)	7.4133	112.7144	0.4470	0.0332	
Exeter River – Exeter Dam* (NHIMP600030805-04)	7.5909	149.5000	1.8361	0.0309	3.7324
Squamscott River South (NHEST600030806-01-01)	8.8743	232.5371	0.5978	0.0918	
Squamscott River North (NHEST600030806-01-02)	9.0676	155.5208	0.4869	0.0539	29.3676
Great Bay Safety Zone 1 (NHEST600030904-02)	8.6573	117.8089	0.3621	0.0864	27.2530
Great Bay Safety Zone 2 (NHEST600030904-03)	8.8782	59.7002	0.2662	0.1590	21.5867
Great Bay Open (NHEST600030904-04-05)	8.4627	49.4913	0.2428	0.0957	15.1462
Adams Point South (NHEST600030904-04-06)	8.5143	22.6361	0.0825	0.0470	9.0000
Upper Little Bay South (NHEST600030904-06-12)	9.0559	29.9169	0.2904	0.0316	15.9371
Adams Point Mooring Field (NHEST600030904-06-10)	7.7900	88.0622	0.3346	0.1196	22.2467
Upper Little Bay (NHEST600030904-06-19)	8.2305	34.5966	0.2803	0.0410	12.9626
Lower Little Bay (NHEST600030904-06-18)	8.1745	22.8302	0.6939	0.0558	12.5542
Lower Little Bay Marina (NHEST600030904-06-14)	7.6321	68.5747	0.2330	0.0200	7.8233

* Data for the Exeter River was limited. BOD was only available for the Exeter Dam, but used for all units. E. coli counts were used
in lieu of fecal coliform.

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BUFFER OPTIONS FOR THE BAY: EXPLORING THE TRENDS, THE SCIENCE, AND THE OPTIONS OF BUFFER MANAGEMENT IN THE GREAT BAY WATERSHED

KEY FINDINGS FROM AVAILABLE LITERATURE

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Acknowledgements

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A. EXECUTIVE SUMMARY

In New Hampshire, the need for trusted, relevant science is experienced at every scale of buffer management, from decisions made by property owners at the water's edge to those of state agencies setting policy for what is permissible on that land. Underpinning each decision are a series of tradeoffs that reflect assumptions held about the impact of that choice on the environment, the economy, and the well-being of the community. This literature review seeks to support these decisions and ground truth those assumptions by presenting a synthesis of available science on the subject of buffer management for the Great Bay Estuary (GBE) and its tributaries in southeast New Hampshire.

The review was commissioned by the Buffer Options for the Bay ("BOB") technical team, which is a component of the larger integrated assessment BOB project entitled "Exploring the Trends, the Science, and the Options of Buffer Management in the Great Bay Watershed." Buffer Options for the Bay is a grant-sponsored collaboration of public, academic, and nonprofit organizations dedicated to enhancing the capacity of New Hampshire stakeholders to make informed decisions that make best use of buffers to protect water quality, guard against storm surge and sea level rise, and sustain fish and wildlife in the Great Bay region. In keeping with this goal, this review has been inspired by typical questions that arise in the course of local buffer management. For example, what role do buffers play in protecting water quality? In mitigating the impacts of flooding and sea level rise? Providing habitat for protected or commercially important wildlife? Enhancing property values? What does the science suggest we do to ensure that buffers can continue to support these services? How much are people "willing to pay" to maintain or avoid loss of these functions?

To help address these questions, this review considered both primary literature and previous literature reviews. The latter includes recent work undertaken by the New Hampshire Association of Natural Resource Scientists, as well as studies by Sweeney and Newbold (2014), Washington State Department of Ecology (Sheldon et al. 2005), Rhode Island Division of Planning (Metz and Weigel 2013), New Hampshire Audubon (Chase et al. 1995), University of Georgia (Kirwan and Megonigal 2013; Wenger 1999), Environmental Law Institute (Environmental Law Institute 2008), and Good Forestry in the Granite State Steering Committee (Bennett 2010). There is an incredible volume of scientific literature relevant to the topic of buffers, and our intention was not to be exhaustive in this review; instead we focus on the most locally relevant science that can be used to address the aforementioned questions in New Hampshire.

From this review, we found that while the best available science provides clear guidance to inform decision-making related to buffer management in New Hampshire, research questions remain. For example, it is clear that buffers can help protect many of the benefits that the GBE and its tributaries provide to surrounding communities such as recreational opportunities and healthy fisheries. This capacity, however, depends on a buffer's particular attributes, including its width, a characteristic of critical importance to all stakeholders and a topic that has received considerable attention in the peer-reviewed literature. While many papers make recommendations for buffer width, these studies often seek to address how wide a buffer would need to be to maintain the types of ecological features or functions found in entirely natural landscapes, such as an assemblage of forest-associated birds. Consequently, they tend to focus on relatively wide margins of land that may not be practical, or even feasible, in some settings. While it is critically important that we understand these minimum widths and hence what aspects of the environment will be degraded with narrower buffers, it is also important that we understand what functions might be provided by the narrower buffers that may be the only feasible option in certain settings. Relatively few studies have focused on the topic of narrower buffers, with the exception of research on nutrient removal. As a result of the limited data on narrower buffers, this review puts forward minimum buffer width recommendations based on what is necessary to maintain buffer functions, with the caveat that we do not always fully understand how well narrower buffers may function. These recommendations are supported by pertinent examples of specific analyses from the literature.

In addition to the limited data available to help in understanding the role of narrow buffers, a challenge also exists in quantifying a direct relationship between the restoration, maintenance, or loss of buffers in real-world scenarios and a corresponding change in the focal ecosystem service. Most primary research on buffer efficacy is conducted under controlled conditions within the confines of a research project. Under this approach, unwanted variability in the environment is minimized in order to test specific hypotheses. However, when buffers are utilized in practice, there is typically considerable variability in the environment, accompanied by a lack of replication – for example, often a single watershed is evaluated. This makes the type of statistical analyses deployed in experimental research difficult. Understanding this challenge is important, as it can lead to a conclusion that, in practice, buffers are not as effective as indicated by most primary research. However, the reality is that the findings of primary research hold true, i.e. buffers can be an effective tool, but the variability of complicating factors in the natural environment can either mask or override the role that buffers play in influencing ecosystem services.

The science synthesized in this document is intended to be used by the BOB project team, although the explicit intent is to then create a number of informational products that translate this science into a more accessible form for end users. Ultimately, the products that are shaped from this review will be of service to all buffer management stakeholders in the Great Bay region, including landowners and the consultants who work with them, regulatory agencies and municipalities, conservation organizations and foundations, and scientists interested in conducting research that will lead to more effective buffer management.

Science, however, is only one piece of the buffer management puzzle. To augment this review, the BOB collaborative has conducted an analysis of regulatory and non-regulatory policy options for New Hampshire, an economic analysis of the values placed on the water quality benefits provided by buffers, a buffer-focused GIS analysis of the GBE region, and an assessment of the barriers and opportunities related to buffer management at the community level in the Exeter/Squamscott subwatershed.

The results of these analyses have been captured in individual reports. They've also been integrated into a framework intended to inform discussions around buffer management, restoration, and protection in the GBE region. We anticipate that this framework will open the door to new and needed research; strategic and complementary investments by state agencies, nonprofits, and foundations; and a collective strategy for outreach professionals to work with towns on advancing effective buffer policy and practice at the community level.

B. WHAT IS A BUFFER?

Before embarking on a review of scientific information relating to buffers, it is important to understand what is meant by this concept. Such understanding is confounded by the range of terminology used in relation to buffers. Two or more terms may be used to refer to what is essentially the same concept, or the same term may be used in different contexts with different underlying meanings. This can lead to confusion that hinders effective buffer management.

For the purpose of this review, *buffer* is defined as an upland area adjacent to wetlands (Sheldon et al. 2005), and *wetland i*s defined as a transitional zone between terrestrial and aquatic habitats that includes landscape features that contain or convey water and support unique plants and wildlife (Environmental Law Institute 2008)[1]. Using these definitions, examples of wetlands could include streams, rivers, ponds, lakes, bogs, and vernal pools. This review is focused on the Great Bay Estuary (GBE) region, and is therefore concerned primarily with coastal buffers (i.e. the boundary adjacent to tidal waters of the estuary), buffers adjacent to streams and rivers that flow into the bay, and buffers adjacent to wetlands that are hydrologically connected to the waters of the bay. The terms listed below are often used, sometimes interchangeably, when referring to areas that fit the aforementioned description of buffers.

- Buffer
- Vegetated filter strip
- Buffer strip
- Riparian area
- Riparian zone
- Riparian corridor

While each of these terms may be more commonly employed in different arenas (e.g. regulation/policy versus ecological condition or location), or more typically associated with a certain definition, there is considerable mixing of usage. Given that the BOB project is not focused on any single specific function of buffers, we use 'buffer' throughout this document in reference to the range of functions that may be encompassed by all of the terms listed above.

[1] One's understanding of the term 'buffer' is often informed by one's background or experience. A planner or developer may consider buffers to be defined regulatory areas in which development may be constrained. A scientist or ecologist may have a much broader and less rigid understanding, characterized more by the ecological setting, form, and function than by a simple regulatory boundary.

In addition to the variation in terminology, a considerable range of definitions are used in reference to buffers. Perhaps the simplest is "*the uplands adjacent to wetlands*" (Environmental Law Institute 2008), i.e. a strictly spatial definition. However, the concept of a buffer is more typically applied to describe a range of land management practices in these upland areas. These practices can range from restricting activities from within a specified distance from a water body (also commonly termed a 'setback') to complex recommendations for habitat management designed to protect specific groups of organisms or functional roles. For example, Reed (2013) defined buffers as "*vegetated strips of land separating runoff- and pollutant-contributing areas from surface waters*." Similarly, Chase et al. (1995), defined a buffer as "*a naturally vegetated upland area adjacent to a wetland or surface water*." Conversely, Semlitsch and Jensen (2001) recommended the following nuanced description for amphibians and reptiles:

"*We propose the use of stratified criteria that would include at least three terrestrial zones adjacent to core aquatic and wetlands habitats: (1) starting from the wetland edge, a first terrestrial zone would buffer the core aquatic habitat and protect water resources; (2) starting again from the wetland edge and overlapping with the first zone, a second terrestrial zone would comprise the core terrestrial habitat defined by semi-aquatic focal species or species-group use; and (3) starting from the outward edge of the second zone, a third terrestrial zone would buffer the core terrestrial habitat from edge effects and surrounding land-use practices.*"

Bearing in mind this range of definitions, in general, the term 'buffer' is used to denote a specified area of upland habitat adjacent to streams, rivers, ponds, lakes, and/or other wetland types, typically associated with maintaining or promoting one or more ecological or socio-economic functions, and with specific land use regulations implemented within this area to meet these objectives. These land use practices can either be activities that are prohibited, such as construction, or encouraged, such as maintenance of natural vegetation. In the ecological literature, the term 'buffer' generally relates to the naturally vegetated zone adjacent to wetlands and precludes consideration of gray infrastructure (i.e. storm sewers, culverts, pipes, other human-engineered systems) that might serve some of the same functions as green or natural infrastructure (i.e. forests, wetlands, other natural ecosystems).

'Setback' and 'jurisdictional zone' are two terms that are often used in similar contexts as buffers – specifically, regarding the regulatory capacity for water body protection. However, setbacks and jurisdictional zones are distinct from buffers. These terms will not be covered in depth in this review, but the following background information is provided to help differentiate setbacks and jurisdictional zones from buffers.

Much like 'buffer,' the term 'setback' has a range of definitions. A setback is generally a specified distance from the water body within which certain activities are restricted, such as building construction or establishment of a septic system. Wetland setbacks are not necessarily naturally vegetated, as setbacks are typically aimed specifically at maintaining water quality rather than the broader goals often targeted by buffers. However, the term 'setback' is sometimes used interchangeably with 'buffer.' An example of one definition is "*a distance requirement from certain activities*," from New Hampshire Department of Environmental Services (NHDES). As another example, the National Oceanic and Atmospheric Administration defines a setback as "*a distance landward of some coastal feature (e.g. the ordinary high water mark within which certain types of structures or activities are prohibited*" (Lemieux et al. 2004).

A jurisdictional zone is another area in which restrictions may be set to protect a water body. A jurisdictional zone is generally the boundary extending out from a water body to which a governing agency (i.e. state and/or municipality) has regulatory capacity. With respect to buffers, a jurisdictional zone typically includes and extends beyond buffer and setback widths. The NHDES Wetlands Bureau defines a jurisdictional zone as "*an area that is subject to regulation under RSA 482-A [Fill and Dredge in Wetlands], as described therein.*" An illustration of the typical spatial arrangement of buffers, setbacks, and jurisdictional zones is provided in Figure 1 below.

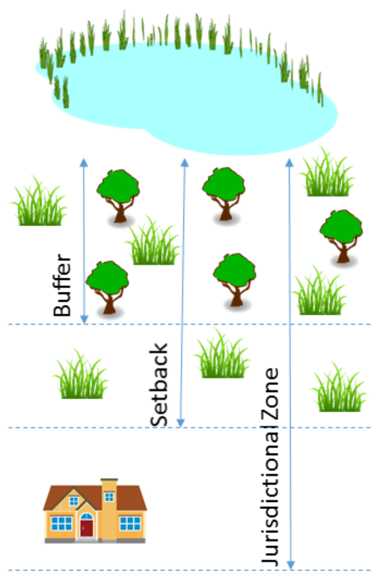


Figure 1. Conceptual illustration of buffer, setback, and jurisdictional zone extents in relation to the water body (not to scale).

C. Which environmental issues do we hope to address through the use of buffers in the Great Bay Estuary (GBE)?

The principal threats to the Great Bay Estuary (GBE) are well summarized in the Piscataqua Region Estuaries Partnership's (PREP) 2013 State of Our Estuaries Report (PREP 2013) and the Great Bay Non-Point Source Study (Trowbridge et al. 2014). These documents and the resources they draw upon describe a complex range of interrelated stressors that have led to ecological degradation and associated socio-economic costs, including terrestrial pollutants from settlements and agriculture, changes in sedimentation, changes in water temperature and levels of dissolved oxygen, loss of natural habitat due to land conversion (Fig. 2a, Fig. 2b), declines in oyster reefs and eelgrass beds, increases in invasive aquatic species and nuisance native macroalgae, altered flow regimes and barriers to the passage of aquatic organisms between marine and freshwater environments, increased flooding and erosion, and sea level rise. Buffers have the potential to help in ameliorating all of these issues with the exception of invasive species, aquatic organism passage for strictly aquatic species, sea level rise, and changes in estuarine water temperature as a result of ocean warming.

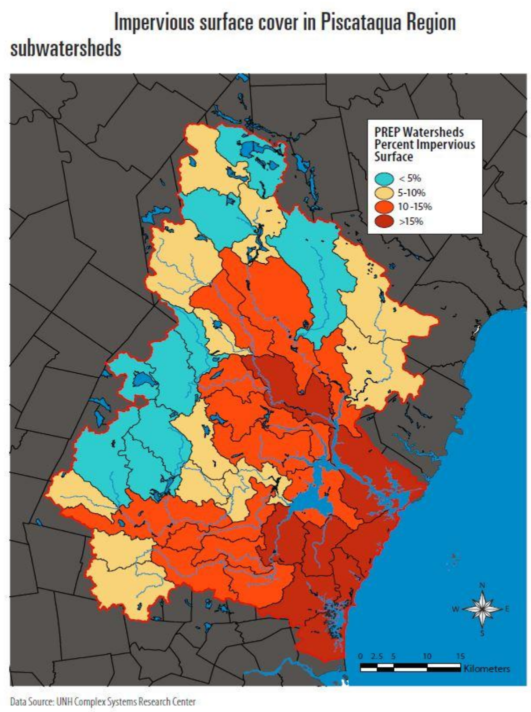


Figure 2a. Impervious surface cover trends in the Great Bay Estuary region. Provided by Piscataqua Region Estuaries Partnership (PREP 2013).

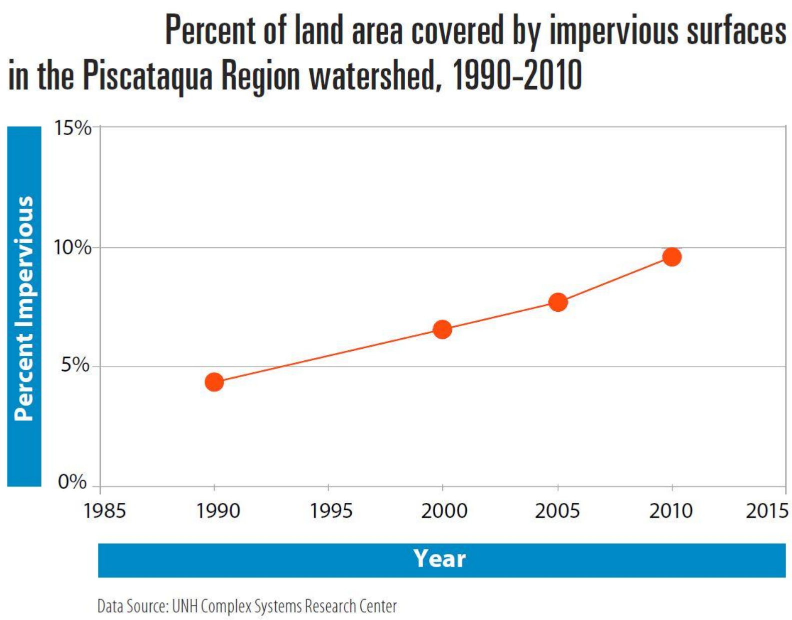


Figure 2b. Impervious surface cover trends in the Great Bay Estuary region. Provided by Piscataqua Region Estuaries Partnership (PREP 2013).

Nitrogen/nutrient loading and sediment inputs to the GBE remain significant drivers of ecological degradation, with high inputs facilitated by the increasing amount of impervious cover and loss of natural cover within the watershed (Trowbridge et al. 2014). Excess nutrient inputs to aquatic systems reduce water quality and decrease species richness. Sixty-eight percent of the nitrogen in the GBE system comes from nonpoint sources spread across the watershed, with the remainder coming from municipal wastewater treatment discharge. Nonpoint sources include atmospheric deposition, fertilizers, human waste from septic systems, and animal waste. Human waste from septic systems contributes 29 percent (~240 tons/year) of nitrogen inputs to the GBE and is the largest nonpoint load after atmospheric deposition (42 percent). Thirty-four percent of nonpoint source loads were delivered through stormwater (surface water of abnormal quantity resulting from heavy rains or snowfall).

The loss of buffers is particularly important in the context of nutrient and sediment inputs. Nitrogen inputs are closely linked to levels of dissolved oxygen (DO): In general, the tidal mixing in the GBE means that levels of DO are above minimum water quality standards of 5 mg/L. However, tidal rivers flowing into the GBE regularly fall below this threshold, posing a risk to aquatic organisms (PREP 2013). Suspended sediments continue to increase in the GBE, having risen by 12 percent from 1976 to 2011. These suspended sediments result from both wave/tidal disturbances to estuarine silts, and run-off delivery of terrestrial sediments into the bay (i.e. a combination of resuspension of existing sediments in the bay, and increased terrestrial inputs). These threats from nutrient and sediment inputs can be ameliorated by the use of buffers.

Increased nutrient levels, coupled with sedimentation and disease outbreaks, are likely to be important contributors to declines of eelgrass and oyster reef areas within the bay (Fig. 3). Historically, there were approximately 1,000 acres of oyster reefs in the GBE, with only ~10 percent of this area now remaining (PREP 2013). Similarly, eelgrass beds once dominated nearshore habitat in the bay, but their distribution has declined by 44 percent since 1996, and their biomass has decreased by 79 percent (Short 2016). The loss of these habitats is particularly notable given the important ecological functions they provide. These include water filtration by oysters, important habitat for juvenile fish and aquatic invertebrates, and estuarine sediment trapping. As these habitats have declined, there is the potential for a feedback mechanism wherein the increased sedimentation and decreased water quality partially resulting from oyster and eelgrass declines creates conditions in which it is harder to restore these same habitats. In addition to this ecological functionality, oysters and seagrass meadows are commercially valuable. For example, a study of Mediterranean seagrass meadows estimated they were annually worth $119 million for commercial fishing (Jackson et al. 2015).

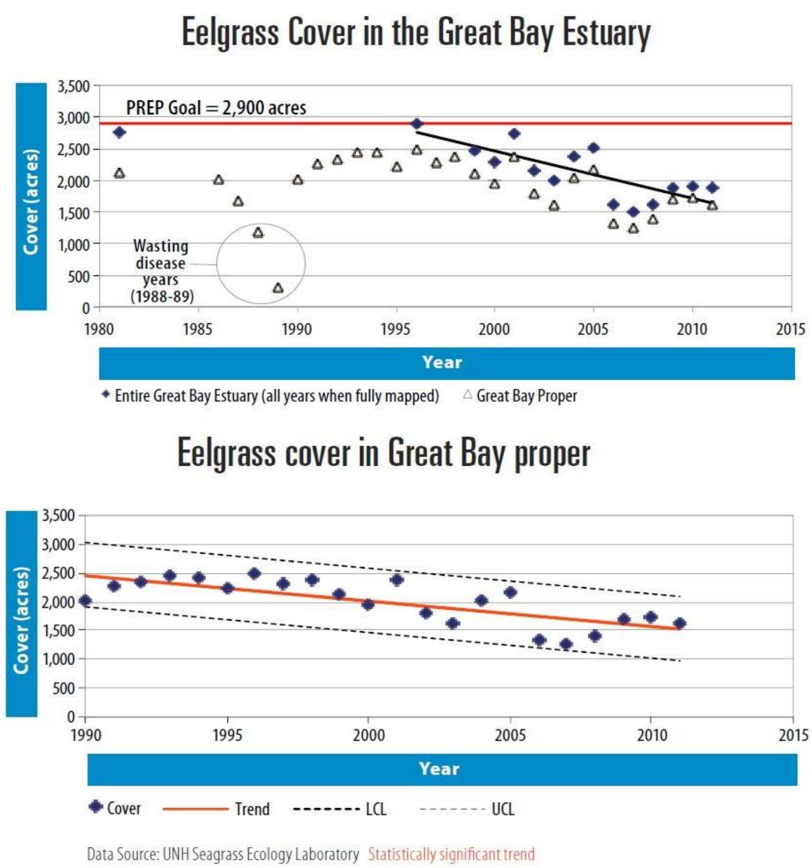


Figure 3. Eelgrass cover trends in the Great Bay Estuary region. Provided by Piscataqua Region Estuaries Partnership (PREP 2013).

Widespread conversion of natural habitats has been deemed the leading cause of biodiversity loss worldwide. Riparian habitat is at particular risk from conversion as these areas are often highly suitable for agriculture and desirable locations for human development. In the United States, ~1 percent of riparian areas were lost from 1972 to 2003 (Pusey and Arthington 2003). While this figure may not seem high, it is important to recognize that this represents a continued loss of habitat on top of historical loss in many places. In coastal New Hampshire, much of this land conversion can be attributed to a growing human population as a result of proximity to the expanding greater Boston area. From 1990 to 2010, the population in the region grew by 19 percent with a concomitant 120 percent increase in impervious cover (representing 9.6 percent of the land area). The loss of buffers is of particular concern given that they support a wide range of organisms associated with both terrestrial and aquatic habitats (Naiman et al. 1993) and are thought to provide connectivity, i.e. allow movement of organisms across the landscape, particularly in situations where upland habitat adjacent to the buffer has been lost (Machtans et al. 2002, Beier and Noss 2008).

In addition to habitat loss, conversion of riparian habitat increases the load of stressors such as nutrients and sediment with little opportunity for ameliorating these threats before they enter wetlands. Areas close to waterways contribute a significant proportion of inputs (~10 percent of nitrogen loading comes from within ~650 ft. of waterways) (PREP 2013). As an example of the consequences of conversion, research in the NH Seacoast region found that water quality and biological conditions in-stream declined as the percentage of urban land increased within an ~80 ft. buffer (Deacon et al. 2005).

Sea level rise (SLR) is also a significant threat to the GBE. While sea levels are rising in many areas of the world as a result of melting polar ice caused by global climate change, the northeastern United States has been identified as a hotspot of accelerated SLR, with rates 3 to 4 times higher than global averages (Sallenger et al. 2012). SLR will lead to extensive coastal flooding (Kirshen et al. 2008), and may lead to the loss of important coastal habitat, such as dunes and salt marshes, depending on the rate of SLR and ability of habitats to redistribute in response to these changes (Craft et al. 2008). The high density of human settlement and associated infrastructure in lowland areas adjacent to the GBE also puts many communities at significant risk of coastal flooding as a result of SLR (Hamilton et al. 2010).

D. HOW MIGHT BUFFERS ADDRESS THESE ISSUES?

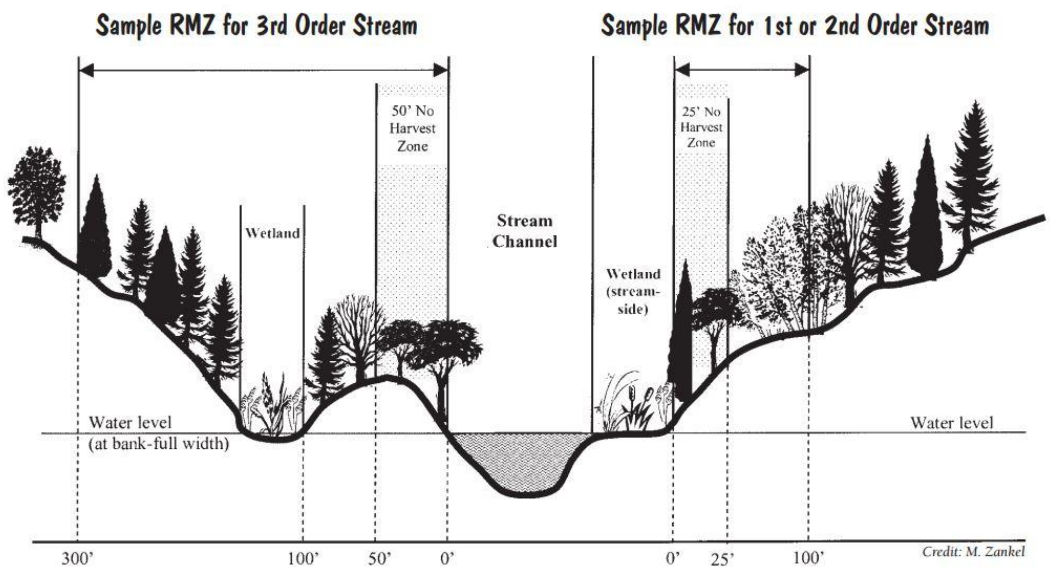
Buffers can provide a range of ecological benefits to help in ameliorating the threats listed above (summarized in Table 2 with a more detailed narrative description provided in the following sections). However, before describing the role of buffers, it is important to recognize that the provision of these services is highly dependent on both the wider landscape within which the buffer is found and the localized context of the buffer itself (Wenger 1999, Franzen et al. 2006, Bardgett et al. 2013, Raney et al. 2014). Landscape context is particularly important as it will influence the nutrient loading that the buffer will intercept. For example, if a buffer is situated in close proximity to a large area of commercial development, there is likely to be a higher loading of contaminants compared to a largely forested watershed. Similarly, the functioning of the buffer will be influenced by a range of characteristics including vegetation, width of the buffer, slope, and underlying soils. We have attempted to discuss these topics throughout this literature review, but an in-depth discussion of topics such as the linkage between watershed management, land-use change, and nonpoint source pollution is beyond the scope of our analyses.

Research has shown that the effectiveness of pollution reduction by 'green' infrastructure, or natural areas that provide ecosystem services (in this case, buffers), is not only comparable to that achieved by 'gray' infrastructure (constructed stormwater interventions), but that green infrastructure typically costs markedly less (Talberth et al. 2012). As watersheds have degraded over time, costs for traditional water treatment have doubled for about one in three large cities globally (McDonald et al. 2016). Specifically, from 1900 to 2005, 90 percent of urban source watersheds experienced some watershed degradation, with the average pollutant yield of urban source watersheds increasing by 40 percent for sediment, 47 percent for phosphorus, and 119 percent for nitrogen (McDonald et al. 2016). By electing to use natural/green infrastructure such as buffers and wetlands, stakeholders avoid watershed degradation. This avoidance in turn helps maintain water quality and reduces treatment costs, as the natural capital of natural land cover functions as an alternative to investment in gray infrastructure (McDonald et al. 2016). As an example of the comparison between green and gray infrastructure, building a wastewater treatment system using constructed wetlands costs around $5 per gallon of capacity compared to approximately $10 per gallon of capacity for a conventional advanced treatment facility (Foster et al. 2011). Additionally, green infrastructure is estimated to be three to six times more effective in managing stormwater per $1,000 invested than conventional methods. For example, the largely intact floodplains and wetlands within Vermont's Otter Creek watershed were estimated to have reduced damage by 54 to 78 percent across ten flood events to the town of Middlebury, and by 84 to 95 percent for Tropical Storm Irene (Watson et al. 2016). The annual value of these flood mitigation services exceeded $126,000 and may be as high as $450,000. Green infrastructure also functions better than gray infrastructure in climate adaptation and resilience by providing a suite of co-benefits, such as improving air quality, reducing urban heat effects, lowering energy demand, and even increasing land values by up to 30 percent (Foster et al. 2011).

Before considering the extent to which buffers can help support specific ecosystem services, it is important to address the overarching topic of buffer width. This theme has received considerable research attention, with a number of review papers offering recommendations for different objectives (e.g. Lee et al. 2004; Kirwan and Megonigal 2013). It is worth noting, however, that studies have tended to focus on relatively wide buffers that may not be feasible in some settings, such as areas where high development pressure impedes the ability to establish buffers of the recommended width.
As a consequence, there is some concern that the efficacy of narrower buffers may not be well understood (Hickey and Doran 2004).

This review provides fixed width buffer recommendations, but we recognize the utility of variable buffer width recommendations as well. Variable width buffers are buffers that do not maintain a uniform width throughout their extent (Fig. 4, Table 1). Variable width buffers can provide an important tool for meeting an ecosystem service target (for example, removal of nutrients), but where it is infeasible to maintain or restore a fixed width buffer. Examples of factors that preclude the use of a fixed width buffer can include adjacent land use, site and stream conditions (i.e. topography, soil, hydrology) and places where buffers have been lost and restoration is not feasible (Environmental Law Institute 2003; Aunan et al. 2005). For example, in places where habitat loss has already led to a fragmented or asymmetrical buffer, greater widths will be needed in remaining habitat to maintain buffer integrity (i.e. for the buffer to provide the same level of ecosystem services) (Barton et al. 1985). Variable width buffers, specifically larger widths, may also be employed to protect pristine or highly-valued riparian areas; areas close to high-impact land use activities; or areas with steep banks, sparse vegetation, or highly erodible soils (Environmental Law Institute 2003).

A recent review undertaken by the New Hampshire Association of Natural Resource Scientists (NHANRS) employed a comprehensive literature review to focus specifically on the topic of buffer widths. Given the overlap between our review and the work of NHANRS (both focusing on buffers in the state of New Hampshire), we have summarized available recommended minimum buffer widths to achieve different objectives at the end of each section below and in Table 3. One can reference the NHANRS review for a complete list of the studies from which these recommendations were drawn (Appendix 1, Appendix 2, Appendix 3).



The left side of the illustration shows the recommended RMZ for a 3rd order stream. The right side shows the recommended RMZ for a 1st or 2nd order stream. Note that the RMZ on the right side is measured from the upland edge of the streamside wetland. If there is no wetland at the edge of the stream, the RMZ is measured from the top of the streambank (at bankfull width). The disjunct wetland on the left side overlaps and is included within the RMZ.

Figure 4. Theoretical illustration of sample recommended riparian management zone (RMZ) delineations for streams of various orders, for the purpose of forest management. Reproduced from *Good Forestry in the Granite State* (Bennett 2010).

Table 1. Sample riparian management zone guidelines in New Hampshire for various water body sizes, for the purpose of forest management. Reproduced from *Good Forestry in the Granite State* (Bennett 2010).

	Legally Required		**Recommended**	
	Riparian Management Zone (ft.)	**No Harvest Zone (ft.)**	**Riparian Management Zone (ft.)**	**No Harvest Zone (ft.)**
Intermittent Streams	None	None	75	None
1st and 2nd Order Streams	50	None	100	25
3rd Order Streams	50	None	300	50
4th Order and Higher Streams	150	None	300	25
Pond (<10 acres)	50	None	100	None
Lake or Great Pond (>10 acres)	150	None	300	25

One caveat when interpreting the findings of different studies in regards to buffer width is that there was some variability in how the width of a buffer was determined based on what constituted the edge of the buffer. Given the abundance of studies focusing on buffer width, our sense is that this additional variability is unlikely to have strongly influenced recommendations, although the relevance of this issue increases when there are relatively few studies supporting specific guidance. The history of development and reforestation seen throughout New England, and particularly in coastal New Hampshire, means it is also important to note that in individual sites, buffer function may be influenced by prior alteration, such as where soils have been heavily modified by past agriculture.

Caveats aside, the overarching message regarding the relationship between buffer width and provision of ecosystem services is a simple one: in general, wider and more forested buffers provide greater benefits to water quality and biodiversity. Another key theme that emerged from research findings is the influence of landscape context on buffer efficacy, including factors such as topography, the location of stressor sources, and the underlying water table. Furthermore, longer, continuous buffers are more effective than fragments of greater widths for hydrologic functions, reducing gaps in maintaining water quality, and wildlife habitat (Fischer et al. 2000). Additionally, wider buffers may be warranted next to particularly sensitive resources (for example, impaired water bodies), and closer to the GBE, where there is less opportunity for excess nutrients that enter streams and rivers to be ameliorated before entering the bay, although research has shown that buffers along headwater streams that feed into a target water body have a greater influence on overall water quality than those directly surrounding that water body (Fischer et al. 2000). The following sections provide a more detailed summary of the state of current scientific knowledge regarding buffer width and the provision of specific ecosystem services. In Table 4, we offer a single recommended minimum buffer width for each specific ecosystem service drawn from our literature review. In addition to these recommendations, we have also compiled gaps in the best available science in Appendix 4 that, if addressed through further research, would improve the recommendations we are able to offer practitioners regarding the use of buffers. It is important to keep in mind that buffer width is one of several factors that determine a buffer's ability to provide a variety of services – considering buffer width alongside linear extent, vegetation composition, and level of permanent protection facilitates more holistic and effective buffer management.

While buffer width is an important indicator of how well a buffer may provide ecosystem services, the composition of the buffer is also a key factor in determining how well a buffer functions. Buffers that are naturally vegetated generally provide ecosystem services to a greater extent than buffers that are sparsely vegetated or have been cleared or altered, such as a forested buffer that has been converted to grass (Bentrup 2008, Castelle et al. 1992, Fischer and Fischenich 2000). To compare, nitrogen uptake and retention were significantly higher in forested buffer sites compared to herbaceous sites – a retention difference between 99 percent and 84 percent, respectively, in one study (Haycock and Pinay 1993, Hefting et al. 2005). Buffers consisting of native vegetation perform better when the vegetation is well-adapted to site conditions and diverse, so the buffer's vegetation captures a wide array of environmental tolerances that support a number of functions (Fischer and Fischenich 2000). The buffer is therefore better able to be resilient in the face of fluctuating environmental variables. When restoring buffers, this diversity can be achieved through utilizing an array of species, growth forms, and life histories. Overall, naturally vegetated, diverse buffers are more effective at reducing pollution into the water body than sparsely vegetated, homogenous buffers.

In summary, buffers can be employed to provide a variety of ecosystem services and mitigate a host of environmental issues, but the extent to which buffers deliver these functions depends greatly on the characteristics of the buffer itself as well as the larger landscape characteristics surrounding the buffer. A central metric in assessing the extent to which a buffer is providing certain functions is the width of the buffer. In the following sections, three overarching themes of ecosystem services that buffers provide – water quality, hydrologic effects, and habitat for biodiversity – are dissected. This analysis serves as an assessment of how buffers specifically deliver these functions and of what widths are generally adequate to provide these services.

I. Water Quality

Buffers contribute to the maintenance of water quality in a variety of often synergistic ways. For instance, sediment removal by buffers may also remove phosphorus bound to sediment particles. A number of studies have made general recommendations for the width of buffers needed to maintain overall water quality. The lowest recommendation is 16-foot. (Fischer and Fischenich 2000), although the majority of studies provide a minimum width of 100-foot (Appendix 1).

Most of the published research on the efficacy of buffers for promoting water quality has focused on naturally vegetated habitat, and it is from this body of work that our recommendations are drawn. However, setbacks that prevent certain land uses or structures, such as the installation of a septic system or construction of a building, within a certain distance from a water body can help to maintain water quality by reducing erosion, pollutant runoff, and runoff flow volume and velocity. The following section provides a detailed commentary regarding the role of buffers in helping to address specific components of water quality.

i. <u>Reducing inputs of excess nutrients and contaminants</u>

Implementing buffers has been shown to be an effective approach in reducing the transport of nitrate and phosphate from agriculture and development (Peterjohn and Correll 1984, Environmental Law Institute 2008). Nutrients are absorbed into the buffer sediment, taken up by plant biomass, and immobilized by microorganisms through denitrification (Hruby 2013). As phosphorus primarily enters buffers attached to sediments or as organic material (Wenger 1999), the role of the buffer in reducing inputs to wetlands conforms to the same mechanisms as that of reducing sediment inputs in general. Experimental research has demonstrated that even narrow grass buffers have the capacity to reduce phosphorus inputs. For example, a 15-foot (4.6 m) grass buffer strip removed 18 to 71.5 percent of total phosphorus (Wenger 1999). When increased to 31-foot (9.6 m), grass buffers removed 46 to 79 percent of phosphorus. In some cases, removal of phosphorus and nitrogen by buffers approached 90 to 100 percent (Hickey and Doran 2004).

One important caveat to these experimental findings is that the effectiveness of the buffers decreased over time, presumably due to previously-trapped phosphorus being re-mobilized (Wenger 1999) and soils becoming saturated by nitrogen (Woods Hole Group, Inc. 2007). It is also important to note that buffer effectiveness may vary *in situ*, since percent removals are dependent upon input load. Furthermore, the depth of the water table in relation to root biomass within the buffer likely plays an important role in influencing rates of nutrient and contaminant uptake (Marczak et al. 2010). Lastly, while grass buffers may effectively reduce nutrient inputs in certain settings, forested buffers may be more effective in providing a broader suite of ecosystem services. Bearing in mind these caveats, buffers with more hydric soil, flatter topography, and a higher water table are typically better able to remove pollutants. Based on models developed for the GBE, watershed conservation efforts (i.e. protection of wetlands and forests) could reduce nitrogen inputs to the bay from three to 28 metric tons per year (Berg et al. 2016).

Buffers are also capable of stabilizing other pollutants, although the buffer widths necessary for effective removal have not been as well-studied. Buffers can render pathogens harmless as they are carried in subsurface flow through the soil, neutralize acid deposited by acid rain through uptake into the forest canopy, and stabilize some metals through adsorption to soil particles (Chase et al. 1995). Furthermore, buffers provide filtration sufficient to trap fuel and lubricants from upslope land uses (Bennett 2010).

The following is a summary of the minimum recommended buffer widths necessary to provide reduction of excess nutrient and contaminant inputs. Much of the pollutant removal may occur within the first 15 to 30 feet of a buffer, but buffers ranging from 30 to 100 feet or more will remove pollutants more consistently (Environmental Law Institute 2008). Based on available literature, the minimum buffer width needed for effective reduction of nitrogen is 60 feet. (Correll and Weller 1989), and the majority of sources recommend a width of at least 98 feet (Appendix 1). The minimum buffer width for effective reduction of phosphorus is 30 feet. (Fischer and Fischenich 2000), and the majority of sources recommend a width of at least 98 feet. (Appendix 1).

ii. <u>Mediating sediment</u>

Buffers can help to reduce issues associated with sediments in three ways: (1) preventing the occurrence or mediating the severity of sediment-producing activities, such as construction or agriculture close to the wetland edge; (2) trapping terrestrial sediments carried in run-off before they enter the wetland; and (3) supporting in-stream conditions that increase sediment deposition and/or reduce erosion, such as reducing the severity of high flow/velocity events from storm flows, stabilizing banks, and contributing woody debris, which traps sediments in the water (Mayer et al. 2007, Liu et al. 2008, Zhang et al. 2010, Kirwan and Megonigal 2013). Since nutrients are often bound to sediment particles, the reduction of sediment transport may also serve to reduce nutrient export from riparian zones (Hickey and Doran 2004). For instance, sedimentation may account for phosphorus retention rates of up to 115 lb/acre/year (Hoffman et al. 2009). Sediment retention is also an important factor in maintaining viable foraging and spawning sites for fish and other aquatic organisms (Chase et al. 1995, Hickey and Doran 2004).

The role of buffers in reducing sediment inputs can be profound (Young et al. 1980, Dillaha et al. 1988, Dillaha et al. 1989, Magette et al. 1989). For example, experimental research demonstrated that a 54-foot buffer consisting of switchgrass and woody vegetation (shrubs and trees) removed 97 percent of the sediment from an adjacent field (Polyakov et al. 2005). Similarly, researchers found that ~65 percent of sediments were trapped by a 33-foot streamside forest buffer and ~85 percent for a 66-foot buffer (Sweeney and Newbold 2014). It is also worth noting that landscape models indicated a high percentage (47 percent) of the total variation in sediment loading to streams could be explained by riparian forest cover, highlighting the importance of buffers in mediating sediment transfer (Jones et al. 2001). While one study found that narrow buffers (16 to 66-foot) are able to remove coarse sediments, wider buffers (66 to 328-foot) are better able to remove finer sediments (Hruby 2013). The minimum buffer width for effective sediment removal is 30 feet (Environmental Law Institute 2008), and the majority of sources recommend a width of at least 98 feet (Appendix 1).

iii. <u>Influencing water temperature</u>

In freshwater systems, vegetated buffers help to regulate stream temperatures by providing shade (Hruby 2013). This is particularly important for cold-water fish, as increases in water temperature also have potentially undesirable effects on stream chemistry, aquatic insects, stream flora, and fish behavior and development (Hagan and Whitman 2000). For example, average stream temperatures increased by 7.9°F after the removal of riparian forest, and there was an 18°F increase in maximum temperature between a clear-cut stream and a buffered stream (Rishel et al. 1982). Furthermore, streams with vegetation removed tend to experience summer temperature increases of 9° to 19.8°F above streams where natural vegetation was maintained (Bentrup 2008). Based on these findings, buffer widths ranging from 25 to 100 feet have been proposed for adequate water temperature modification (Barton et al. 1985, Bentrup 2008, Osborne and Kovacic 1993), with a recommended minimum of 30 feet based on a synthesis of available literature (Wenger 1999).

iv. <u>Providing organic inputs into aquatic systems</u>

Buffers contribute leaf litter, detritus, small woody debris, and insects to adjacent aquatic ecosystems. These important energy inputs drive aquatic ecosystem food webs (Naiman et al. 2002, Fisher and Likens 1972, Golladay et al. 1992, Wallace et al. 1997). Larger coarse woody debris inputs into streams and rivers are important for creating the range of different environments required by organisms for shelter, foraging, hibernation, and reproduction, including pools, riffles, debris jams, and related structural aquatic habitat (Chase et al. 1995, Fischer and Fischenich 2000). They also help to retain sediments and nutrients, and influence channel morphology (Naiman et al. 2002). Reid and Hilton examined how wide buffers would need to be to maintain tree-fall rates similar to those in undisturbed forest and to provide coarse woody debris to the riparian area. They recommended a buffer width of 4 to 5 tree heights, with a tree height being defined as the average maximum height of the tallest dominant trees (200 years or older) for a given site class (Reid and Hilton 1998). Similarly, Bentrup (2008) recommended a buffer width from 100 to 400 feet for adequate woody debris and litter input. Based on a summary of the available literature, Wenger (1999) recommended a minimum buffer width of 50 feet to provide sufficient woody debris to streams.

II. Hydrologic Effects

Buffers provide a range of hydrologic ecosystem services that may be particularly important given evidence of the increasing frequency of "extreme" weather events. Total annual precipitation in the northeast United States has increased over the past century, with intense storm events occurring with more frequency (Smith et al. 2008b). As of 2008, the cost of repairing damages from flooding and fluvial erosion was $6 billion per year in the United States; this has likely increased since then (Smith et al. 2008b). Vegetated buffers reduce the severity of flood events by intercepting overland flow from precipitation and meltwater and by allowing for greater infiltration. The majority of studies focusing generally on the hydrologic ecosystem services provided by buffers have recommended a width of 98 feet to maintain these services (Appendix 2), with a minimum recommendation of 33 feet (Wenger 1999, Fischer and Fischenich 2000). Specific discussion of the role of buffers in flood storage, run-off reduction, and bank stabilization is provided below.

i. <u>Providing flood storage capacity</u>

Buffers promote floodplain water storage and minimize downstream flooding potential in a variety of ways. They intercept overland flow and increase water retention time, which result in reduced flood peaks (Fischer and Fischenich 2000). They also regulate stream flow and facilitate infiltration of surface water, which lead to less severe water level fluctuations during storm events (Bennett 2010, Chase et al. 1995). This regulation of water level fluctuation is important since sudden, high magnitude fluctuations often destroy wetland vegetation, particularly along the wetland edge. This loss of native wetland vegetation can then lead to an increased abundance of invasive plant species and alteration of invertebrate communities (Castelle et al. 1992). The minimum buffer width recommended for effective flood storage was 66 feet (Fischer and Fischenich 2000), with recommendations of minimum widths up to 492 feet (Fischer and Fischenich 2000) or 25 feet beyond the extent of the 100-year floodplain (Bennett 2010).

ii. Reducing run-off and stabilizing the channel bank

Vegetation within buffer areas stabilizes riparian shorelines through complex root systems that are often able to withstand cyclic flooding, ice scour, and natural erosion (Chase et al. 1995). The role of root systems in stabilizing shorelines depends on the plant taxa: herbaceous plants with fibrous root systems protect banks from surface erosion, and woody species with deeper roots increase soil cohesion and reduce mass slope failure (Bentrup 2008). Buffers also impede the flow of water runoff by allowing it to percolate into the ground, which preserves soil composition in periods of intense rainfall (Castelle et al. 1992). Likewise, foliage and branches reduce wind energy by physically interrupting flow paths (Bentrup 2008). In fact, a vegetative windbreak protects a downwind area that is ten to 15 times the height of the trees – a service that reduces soil erosion and stabilizes the soil (Bentrup 2008). The minimum buffer width reported for effective bank stability and run-off reduction was 164 feet (Environmental Law Institute 2008).

iii. Infiltrating surface water

Infiltration is defined as the process by which surface water enters the soil. While we were unable to find specific buffer width recommendations for infiltration in the literature, it is important to recognize the benefit that buffers provide by infiltrating surface water. Infiltration allows pollutants and sediment to be intercepted and removed from the water column before reaching the water body (Sweeney and Newbold 2014). Infiltration also reduces the severity of flood events, as mentioned previously. Coarser-textured soils, such as sandy soils, typically have higher infiltration than finer-textured soils (Bentrup 2008).

III. Habitat for Biodiversity

Buffers provide vital habitat for a diversity of aquatic, semi-aquatic, and terrestrial fauna. Specifically, buffers serve as important sites for foraging, hibernation, breeding, nesting, connectivity and escape from flooding (Groffman et al. 1991, Naiman et al. 1993). Buffers also provide visual separation between wetlands and developed environments, thereby reducing noise and light pollution to sensitive wildlife (Castelle et al. 1992). Nearly 80 vertebrates (bird, mammal, reptile and amphibian) species in the northeastern US have a strong preference for riparian habitats (DeGraaf and Yamasaki 2000). Similarly, of the ~450 species of reptiles, amphibians, mammals, and birds that occur in New Hampshire, ~90 depend on wetlands during some phase of their breeding cycle, and 50 more use wetlands for breeding or foraging habitat (Chase et al. 1995). This amounts to about one-third of New Hampshire's native wildlife depending on aquatic and wetland habitat. There are also a host of rare plants and natural communities associated with riparian areas.

It is important to note that while many species prefer buffers compared to terrestrial habitat farther from the wetland edge, this does not necessarily mean that maintaining buffers alone is sufficient to ensure their needs are met. A seminal meta-analysis undertaken by Marczak et al. (2010) assessed whether forested riparian buffers maintained riparian fauna at densities close to those found in unharvested forest. They found that whether forested buffers alone were sufficient to maintain largely unaltered patterns of abundance depended on the taxa: Amphibians were less abundant in forested buffers compared with control sites in unharvested forest. Small mammals demonstrated a marginally decreased abundance in buffers compared with control sites. Birds were slightly more abundant, however, the species composition of avifauna switched to more edge-associated species. Arthropods were the only taxa assessed in which an increase in abundance was found in buffers compared to control sites. Furthermore, the review found no relationship between buffer width and the magnitude of difference (effect size) between buffers and control sites. This review clearly demonstrates that the maintenance of buffers alone is likely to be insufficient if the management goal is to retain areas of natural habitat with the same suitability found in unaltered terrestrial landscapes. While buffers do support a host of wildlife species, they do not do so to the extent that unaltered terrestrial landscapes do.

While the meta-analysis undertaken by Marczak et al. (2010) did not find a significant relationship between buffer width and the quality of riparian habitat, variation in the known ecology of individual species and taxa provides compelling evidence that minimum buffer widths will vary among different organisms. For example, wood frogs (*Lithobates sylvaticus*) range considerably farther from the wetland edge compared to spotted salamanders (*Ambystoma maculatum*), thus the area of buffer needed to ensure most of the population is distributed within suitable forested habitat varies between the two species (Harper et al. 2015). Since the buffer widths required for wildlife habitat are generally larger than those required for other buffer functions, ensuring wildlife protection when determining buffer widths will in turn protect the other various buffer functions. Generally, the wider the buffer width, the greater the habitat diversity, which can support a greater number of wildlife species (Chase et al. 1995). The majority of published studies have recommended a minimum width of 328 feet for wildlife in general, i.e. considerably wider than recommendations for most other buffer functions (Appendix 3). Discussion of specific recommendations for individual taxa is provided below.

i. <u>Aquatic macroinvertebrates and fish</u>

Aquatic macroinvertebrates and fish are known to be sensitive to changes in habitat structure and function, hence their common usage as indices of biotic integrity (Lammert and Allan 1999, Herlihy et al. 2005). Buffers can play an important role in determining this habitat structure by maintaining inputs of organic material as a basis for aquatic food webs, providing woody debris and hence habitat heterogeneity in the stream, maintaining water quality, reducing inputs of terrestrial sediments, and supporting lower water temperatures and higher concentrations of dissolved oxygen through shading

(Jones et al. 2006). The maintenance of buffers is clearly of greater importance for those species and taxa that are particularly sensitive to alteration of natural conditions in the aquatic environment. Examples of these include cold-water associated species such as brook trout (*Salvelinus fontinalis*) and other salmonids where suitable spawning habitat can be degraded by increased sedimentation leading to lower reproductive success (Scrivener and Brownlee 1989). The majority of published studies have recommended a 98-foot buffer for adequate fish and aquatic macroinvertebrate habitat (Appendix 3), although recommendations of over 300 feet have been suggested for the latter taxa (Environmental Law Institute 2003).

ii. <u>Amphibians</u>

Terrestrial habitat adjacent to wetlands is widely recognized as critical habitat for many amphibian species (Semlitsch 1998). Juvenile and adult amphibians such as mole salamanders (*Ambystoma sp.*), wood frogs (*Lithobates sylvaticus*), and American toad (*Anaxyrus americanus*) spend much of their time in upland habitat. As the majority of animals tend to remain close to suitable wetland breeding habitat (Rittenhouse and Semlitsch 2007) and many species of amphibians in the northeastern US are considered forest-associated (Gibbs 1998), maintaining naturally vegetated buffers is considered critical to local population persistence (Harper et al. 2008). As amphibians differ in vagility, estimates of the extent of terrestrial buffer needed to ensure population persistence vary among species. A meta-analysis undertaken by Harper et al. (2008) estimated that buffers would need to be 3,281 feet wide to encompass 100 percent of the wood frogs in a population and 951 feet wide for spotted salamanders. The review undertaken by NHANRS reported a mean recommended minimum buffer width of 256 feet (Appendix 3). In addition to providing critical habitat for local populations of amphibians, wetland buffers may also help to foster connectivity within metapopulations (Baldwin et al. 2006). Recent work has highlighted the importance of this inter-population movement in maintaining the persistence of regional populations of amphibian species (Harper et al. 2015).

iii. <u>Reptiles</u>

Similarly to amphibians, many species of reptiles are reliant on suitable aquatic and terrestrial habitat in order to complete their life history cycles (Bennett 2010, Semlitsch and Bodie 2003). Species such as common snapping (*Chelydra serpentina*) and painted (*Chrysemys picta*) turtles spend the majority of their time in wetlands and rivers, emerging onto land to lay eggs or to move in search of more suitable habitat (Gibbs et al. 2007). Other species such as Blanding's (*Emydoidea blandingii*), wood (*Glyptemys insculpta*), and spotted turtles (*Clemmys guttata*) roam more widely in the terrestrial environment, often accessing a number of different wetlands throughout the year (Arvisais et al. 2004, Joyal et al. 2001, Refsnider and Linck 2012). Maintaining buffers for these organisms is particularly important as their reliance on wetlands and uplands means that individuals are often concentrated immediately adjacent to the wetland edge. If habitat alteration (particularly road development) occurs along this wetland interface, significant mortality can occur, leading to reduced abundances and population viability (Gibbs and Shriver 2002, Aresco 2005). For wide-ranging species, riparian buffers may also form important movement corridors, thereby increasing the probability of persistence of both local and regional populations (Arvisais et al. 2002, Shoemaker and Gibbs 2013). Estimates of the minimum buffer widths needed to maintain adequate reptile habitat ranged considerably from 100 feet (Bentrup 2008) to more than 3,000 feet (Kiviat 1997), with a median minimum of 417 feet (Appendix 3).

iv. <u>Birds</u>

Many species of birds demonstrate a preference for habitat on the wetland/upland interface for nesting, foraging, and movement among adjacent areas (Bennett 2010, Naiman and Decamps 1997). In fact, avian density and species richness in riparian areas have been estimated to be nearly double the amounts in upland areas (Medina et al. 2016). Maintaining buffers in otherwise altered landscapes can conserve the preferred riparian habitat (Machtans et al. 2002), although the extent to which the needs of birds are met is dependent on both the characteristics of the buffer (habitat type, width, and landscape context) and the requirements of individual species (Saab 1999, Shirley 2004, Smith et al. 2008a). For example, buffers are often occupied by more ubiquitous edge species rather than those typically found in the forest interior (Whitaker and Montevecchi 1999, Pearson and Manuwal 2001, Marczak et al. 2010), with buffers of more than 147 feet needed to conserve the latter taxa (Pearson and Manuwal 2001, Shirley and Smith 2005, Shirley 2006). Given variation in the needs and sensitivity of different bird taxa to habitat alteration, recommended minimum buffer widths also vary: the mean minimum buffer width for adequate waterfowl habitat was 108 feet (Appendix 3), whereas the minimum width for adequate passerine bird habitat was 200 feet (Boyd 2001; Bentrup 2008), and the majority of sources have recommended a minimum width of 328 feet for adequate bird habitat overall (Appendix 3).

v. <u>Mammals</u>

Mammals in New Hampshire vary in their preference for buffer habitat. Species such as river otter (*Lutra canadensis*), mink (*Neovison vison*), beaver (*Castor canadensis*), and American water shrew (*Sorex palustris*) are wetland obligates that use buffers as critical habitat for feeding, cover, denning, and travel ways. Species such as moose (*Alces alces*) are also closely associated with wetlands and the wetland/upland interface during summer months when they use these areas for browsing, escape from insects and predation, and thermoregulation (Koitzsch 2002). Similarly, southern bog lemming (*Synaptomys cooperi*) and snowshoe hare (*Lepus americanus*) are often found at higher abundances in upland habitat adjacent to wetlands, likely as a result of the availability of browse and escape cover (D. Patrick, unpub. data).

In addition to the need to conserve buffer habitat for mammalian species reliant upon this resource, maintaining buffers in otherwise altered landscapes can also support the continued persistence of species distributed more widely across upland habitat (Cockle and RIchardson 2003, Marczak et al. 2010). For example, research in agricultural landscapes in southern Quebec reported 14 species of small mammals in remnant riparian buffer strips (Maisonneuve and Rioux 2001). The value of buffers in altered landscapes for maintaining regional connectivity has been a topic of considerable debate, however there is compelling evidence to indicate that retaining or restoring connectivity among otherwise isolated patches of suitable habitat is likely to increase the likelihood of population persistence (Beier and Noss 2008).

Despite the likely importance of buffers for mammalian species, relatively little research has focused explicitly on determining minimum buffer widths (Wenger 1999). Similarly to other taxa, this minimum is heavily influenced by the needs of the species, habitat structure within the buffer, and the surrounding landscape context. Bearing this in mind, a minimum recommended buffer width for adequate mammal habitat of 100 feet has been proposed (Bentrup 2008) with the mean minimum buffer width recommended of 245 feet in the published literature (Appendix 3).

Table 2. Benefits conveyed by buffers.

Buffer Function	Benefit	Attributes of Buffer
Water Quality	Reducing inputs of excess nutrients and contaminants	Highly dependent on soil type, vegetation type, topography, hydrology
	Mediating sediment	Assumes vegetated buffer
	Influencing water temperature	Assumes buffer with tall vegetation adjacent/over water body, typically forested
	Providing organic inputs into aquatic systems	Assumes vegetated buffer
Hydrologic Effects	Providing flood storage capacity	Assumes vegetated buffer
	Reducing run-off and stabilizing the channel bank	Typically assumes forested buffer
	Infiltrating surface water	--
Habitat for Biodiversity	Aquatic macroinvertebrates and fish	Buffer habitat must meet species' needs
	Amphibians	
	Reptiles	
	Birds	
	Mammals	

Table 3. Summary of minimum recommended buffer widths by overall buffer function from the literature.

Buffer Function	Minimum Width Recommended by Study Authors	Median Width Recommended by Study Authors	Maximum Width Recommended by Study Authors
Water Quality	16 feet	100 feet	400 feet
Hydrologic Effects	33 feet	98 feet	330 feet
Habitat for Biodiversity	50 feet	328 feet	1,969 feet

Table 4. Summary of minimum recommended buffer widths by ecosystem service provided by each buffer function from the literature.

Buffer Function	Benefit	Recommended Buffer Width
Water Quality	Reducing inputs of excess nutrients and contaminants	98 feet
	Mediating sediment	98 feet
	Influencing water temperature	30 feet
	Providing organic inputs into aquatic systems	50 feet
Hydrologic Effects	Providing flood storage capacity	66 feet
	Reducing run-off and stabilizing the channel bank	164 feet
	Infiltrating surface water	None found
Habitat for Biodiversity	Aquatic macroinvertebrates and fish	98 feet
	Amphibians	256 feet
	Reptiles	417 feet
	Birds	328 feet
	Mammals	245 feet

E. WHAT PREVIOUS AND ONGOING ATTEMPTS HAVE BEEN MADE TO ADDRESS ECOLOGICAL STRESSORS AND MAINTAIN ECOSYSTEM SERVICES USING BUFFERS, AND WHAT TECHNICAL BARRIERS HAVE BEEN ENCOUNTERED?

Given the likely efficacy of buffers in reducing ecological stressors and maintaining ecosystem services, it is not surprising that a number of watersheds in the United States have attempted widespread implementation of buffer conservation and restoration. While the intensity of these efforts and the context within which they have occurred varies considerably, important lessons can be learned from reviewing the following case studies. These have been chosen based on their description of the implementation strategy (quantification of approaches or methods used), relevance of watershed scale (similar to the scale at Great Bay), inclusion of a quantification of outcomes (tangible results for lessons learned from the implementation), and similar ecological/social/cultural/regulatory context to the Great Bay watershed. Primarily, these studies were conducted in North America. Presentation of these case studies is organized by relevant "frequently asked questions."

I. What successes have arisen from buffer restoration and protection attempts?

The following case studies represent examples of buffer restorations that have been "successfully" employed, i.e., natural vegetation has been re-established. Where information is available, we have also discussed the evidence that these restoration efforts have resulted in quantifiable benefits to target ecosystem services. Also included are case studies highlighting successful protection efforts that have maintained functional buffers in places where they still occur. Compared to restoration, fewer case studies have quantified the ecosystem service benefits of protection of existing buffers. More specifically, we were unable to find watershed-scale case studies that had compared the benefits of using available resources to conserve existing buffers versus restoring lost buffers. We flag this as a research gap given that restoration is often costly and not always successful.

i. <u>North Hampton, New Hampshire</u>

Various water quality and habitat improvement projects throughout the Northeast have specifically implemented buffer restoration and protection as their keys to success in meeting their objectives. As a local example, riparian buffers have been restored at the Sagamore-Hampton Golf Course in North Hampton, New Hampshire through the New Hampshire Sea Grant's Coastal Research Volunteers program (Fig. 5). More than 100 trees and shrubs were planted in early summer 2016, including river birch (*Betula nigra*), sweet pepper bush (*Clethra alnifolia*), and fragrant sumac (*Rhus aromatic*, Gro-lo cultivar). As of August 2016, survival was 100 percent, despite the drought (A. Eberhardt, pers. comm.).

Figure 5. Pre- and post-restoration photos of a riparian buffer area in North Hampton, New Hampshire. Photos provided by New Hampshire Sea Grant.

ii. Connecticut River Watershed

Floodplain restoration along the Connecticut River is another example of a project that has successfully implemented buffer restoration and protection in the Northeast. Since 2009, The Nature Conservancy and partners have spearheaded an effort to protect and restore floodplain forest within the Connecticut River watershed. This initiative began with prioritization of tracts for protection and restoration based on criteria including the existence of low, regularly flooded terraces and extensive shoreline, the potential of the tract to serve as a linkage to protected areas across the river, and location of the tract in an active river area of the Connecticut. Within these priority areas, the Conservancy and its partners have implemented an adaptive management approach to restoration that will help determine the most cost effective approach to bring back silver maple (*Acer saccharinum*), American elm (*Ulmus americana*), and other native floodplain species on floodplain terraces that have a hydrologic regime to support this habitat into the future. These efforts have led to an increased understanding of the most appropriate management techniques for successful restoration (Marks 2013), as well as forested riparian buffer restoration on a number of properties, including the 252-acre Potter Farm tract in New Hampshire.

iii. Chesapeake Bay Watershed

A third example of a successful, targeted buffer restoration project is within the Chesapeake Bay watershed. Forested buffers have been planted within the watershed since 1996, covering more than 8,152 miles (Chesapeake Bay Program 2013). The initiative has been undertaken through the implementation of riparian forest buffer incentive programs, most notably the Conservation Reserve Enhancement Program (CREP). In the most productive years, the bay states averaged 830 miles of buffers alongside riparian areas restored per year. Proper use of tree tubing and herbicide application were found to greatly improve restoration success (Chesapeake Bay Program 2013).

iv. Columbia River Watershed

In other areas of the United States, buffer restoration projects have had success in targeting areas impacted by forestry and agriculture. In the Columbia River watershed in the western United States, since the 1960's buffer areas have been added to reduce the impacts of logging – in particular, slope failure and soil erosion (National Research Council 2004). Additionally, Washington State's Conservation Reserve Enhancement Program (CREP) has provided financial incentives for farmers to restore riparian buffers on agricultural land for nearly 20 years. Survival of planted vegetation ranged from 75 percent to 90 percent throughout the state, with most positive results seen after 5+ years of the buffer being implemented, especially for canopy cover, which provides the service of shading the buffer and adjacent water body (Smith 2012).

v. Fox Creek Canyon, Oregon

In Oregon in 2003, the Fox Creek Canyon underwent a restoration project coordinated by various partnering agencies to mitigate the degradation caused by open-range cattle grazing. Sixteen acres were seeded with native grasses, 4,000 native cuttings and seedlings were planted, and 7 miles of fence were installed to exclude cattle (Machtinger 2007). Results were not quantified, but grasses and forbs had regenerated on the banks of Fox Creek within two years of the restoration efforts.

vi. Bog Brook, New Hampshire

Various other projects in the Northeast and western United States that included buffer restoration as a component of their water quality and habitat improvement techniques demonstrated successes, although the degree to which buffer restoration contributed to the successes remains indeterminable. A buffer was implemented as part of a streambank stabilization project at Bog Brook in the upper Connecticut River basin of northern New Hampshire, an area dominated by agriculture. Riparian vegetation was removed decades ago, presumably to increase the arable land area available, which caused streambank erosion and a subsequent decline in water quality (U.S. Environmental Protection Agency 2006). In 2004, the streambank was stabilized through natural stream channel design, including planting of deep-rooted shrubs to form a vegetated buffer to supplement the shallow-rooted (six-inch) grasses in existence. The shrubs consisted of alder and willow, among others. One-year post-construction, the vegetation was well-established and firmly rooted, and the channel had become more narrow and deeper, both indicative of channel stability. Because of this restoration, Bog Brook was reclassified as "Fully Supporting" from "Impaired" by the New Hampshire Department of Environmental Services.

vii. Mousam Lake, Maine

Another project that included buffer implementation to address water quality issues was the restoration of Mousam Lake's shoreline in southern Maine. The lake's water quality had been in decline for decades due to excessive phosphorus inputs via stormwater runoff. However, after ten years of nonpoint source pollution control projects that started in 1997, water clarity increased by three feet, the lake was in a stable or improving trophic state, and it attained water quality standards set by the Maine Department of Environmental Protection, thereby allowing it to be removed from the list of impaired water bodies (U.S. Environmental Protection Agency 2008). Best management practices, including vegetated buffer plantings, were installed along the lake shoreline at 45 priority sites to stabilize erosion and improve roadside drainage and gravel road surfaces. The associated reduction in pollutant loading to the lake was more than 150 tons of sediment and 130 pounds of phosphorus per year – this equates to a ten percent reduction in phosphorus to the lake. Consequently, this high profile work inspired protection efforts on several neighboring lakes.

viii. <u>Highland Lake, Maine</u>

Similarly, buffer restoration was one method used to combat water quality declines in Highland Lake outside of Portland, Maine. In the 1980's and 1990's, the lake showed signs of declining water quality caused by excessive soil erosion throughout the watershed. Restoration work beginning in 1997 addressed significant erosion sites and reduced polluted runoff by planting more than 1,000 shrubs, trees, and groundcovers, and installing other best management practices such as water bars, rain gardens, and riprap. Lake water clarity stabilized and met water quality standards, thereby allowing it to be removed from the state's list of impaired water bodies in 2010. Furthermore, the amount of sediment and phosphorus exported to the lake declined significantly; it was estimated that pollutant loading was reduced by 278 tons of sediment and 1,070 pounds of phosphorus per year (U.S. Environmental Protection Agency 2010).

ix. <u>Gila River Watershed</u>

Although not topographically similar to the Northeast, the Gila River watershed provides another example of buffer restoration and protection being used to revive an impaired watershed successfully. Portions of the watershed within Arizona and New Mexico have been degraded by past fire management, logging, and domestic grazing practices, thereby reducing water quality, species diversity, and floodplain function (Natural Resources Conservation Service 2006). Protection and restoration efforts began in the late 1970's and included prescribed fire, improved livestock and off-road vehicle management, and the use of bioengineering techniques. Protection and restoration of the riparian area appears successful, as a new rare species of stonefly was observed during biotic condition index monitoring, breeding numbers of the southwestern willow flycatcher increased, and sediments and ash were observed to be trapped onsite rather than lost downstream.

II. What obstacles have been encountered in buffer restoration and protection attempts?

While numerous buffer restoration and protection projects have been successful, others have faced challenges in their implementation strategies. The following case studies serve as examples of efforts that involved roadblocks, both on-the-ground and conceptually. We also highlight certain obstacles faced by a land trust in its attempt to protect buffers through regulatory framework.

i. <u>Chesapeake Bay Watershed</u>

The Chesapeake Bay watershed's buffer restoration initiative has suffered various setbacks in its watershed-scale attempt to improve the bay's water quality. Based on the number of miles planted, restoration efforts have decreased notably since 2009, likely as a result of declining interest, lack of noticeable effect on water quality and habitat improvement, scarcity of funding, and increased challenge (i.e. most accessible or easiest areas have already been planted). This is despite the fact that forest buffers are one of the most cost-effective methods of improving water quality in the bay. Early plantings suffered from lack of proper site preparation and maintenance (e.g. competing vegetation, lawn mowing, deer browse), which caused planting failure and discouraged stakeholders going forward. Another obstacle was that the CREP program has not been open for enrollment for various periods throughout the restoration effort, and these interruptions in program delivery increased skepticism about program viability. Furthermore, as enrollments in the CREP program expire, it may take up to three years to secure re-enrollment; the amount of effort and financial investment put into initially securing these contracts could easily be canceled out by landowners not re-enrolling (Chesapeake Bay Program 2013).

ii. <u>Connecticut River Watershed</u>

Similarly, the Connecticut River floodplain restoration project in New Hampshire has elucidated some policy-based tensions and on-the-ground hurdles. While a number of buffer protection and restoration projects are underway, the path to reaching a scale at which these efforts translate into large-scale restoration of floodplain forest within the watershed is not yet clear. One particular challenge comes from the fact that productive agricultural lands tend to be concentrated in floodplain lands, particularly in New Hampshire, where only seven percent of the state is considered to be well-suited for agriculture. Thus there is a tension between restoring buffers and maintaining active farming. Furthermore, competition caused by invasive plant species such as oriental bittersweet (*Celastrus orbiculatus*) can lead to high mortality of planted seedlings, particularly in the lower portion of the watershed.

iii. <u>Maidstone, Vermont</u>

As an example of a specific project in the Connecticut River floodplain that has faced hurdles on-the-ground, buffer restoration conducted on one of The Nature Conservancy's preserves in Maidstone, Vermont faced various challenges post-restoration (Fig. 6). The Conservancy partnered with the local Natural Resources Conservation District to install a 100-foot buffer along three sections of eroding riverbank in different years, but the banks have continued to erode and have cut into the restored areas. Additionally, plantings have struggled to survive due to grass competition, lack of water upon installation, and deer herbivory. Wherever possible, the partners have since attempted to plant further back from the bank and to plant widths greater than 100 feet to allow for some bank erosion in this naturally meandering section of river. One year after planting, mesh tubing was installed to protect against deer herbivory. The Nature Conservancy employs an adaptive management approach for all buffer restoration projects in the Connecticut River watershed, thereby allowing flexibility in post-restoration management approaches depending on the outcomes observed following the restoration work. Through the adaptive management strategy, the lessons learned from restoration challenges can be employed in subsequent restorations, thereby facilitating more effective approaches in the future.

Figure 6. Before (left) and after (center, right) photos of buffer restoration from The Nature Conservancy's Maidstone Bends Preserve along the Connecticut River in Maidstone, VT. Photos provided by The Nature Conservancy in Vermont.

A review of six national case studies focused on riparian buffer projects highlighted the top challenges that the projects faced throughout the United States. The greatest obstacle identified was securing funding (Frey 2013). Invasive species and survival of planted trees also ranked highly as common issues encountered. Another stumbling block was the difficulty of working with private landowners, which encompassed coordination of multiple sites, willingness of property owners to consider buffer implementation, and concern about "giving up" land to buffers. Other issues that arose during implementation projects included weather events that affected the survival of plantings (e.g. severe wind storms, landslides) (Bisson et al. 2013) and lack of long-term monitoring for plantings to determine persistence of efficacy (Smith 2012).

Lastly, there are various obstacles to enacting regulatory buffer protections, which the Pennsylvania Land Trust Association (2014) outlined. For instance, landowners and other community members may not appreciate the value of buffers or the areas that they protect. People who have a financial interest in development or those who are ideologically opposed to development restrictions may push back against proposed regulatory protections. Likewise, some may want to exempt certain agricultural or forestry practices from restriction. Lastly, finding agreement on an adequate buffer width that is both ecologically sound and politically acceptable may be difficult (Pennsylvania Land Trust Association 2014).

III. What are the overarching lessons learned from buffer restoration and protection attempts?

A number of overarching lessons can be drawn from our case study review. While appropriate methods for successfully restoring buffers are now well-understood, factors such as invasive species and browsing herbivores can still lead to challenges. Additionally, there has been success in restoring buffers at scale in some places, but in other areas, the path to large-scale restoration is not clear, and maintaining the energy required to propel restoration efforts over time is difficult. Furthermore, there is some concern that restoration may take precedence over conservation of buffers. This may be true, given that natural buffers have already largely been lost throughout the Northeast, but it is important to recognize the value of proactively maintaining what we already have, rather than reacting to restore what has been lost.

Programs that have implemented restoration projects also provide important "lessons learned" for future efforts. One major theme is the need to secure adequate funding, including resources to support landowner outreach and maintenance of established buffers by encouraging enrollment as well as re-enrollment in restoration programs (Chesapeake Bay Program 2015). Conservation Reserve Enhancement Program (CREP) and Environmental Quality Improvement Program (EQIP) funding should be utilized to their fullest extents – there is no established funding limit for CREP, and most states are well under their CREP acreage caps (Chesapeake Bay Program 2013).

Another important lesson regarding buffer restoration is the need to employ an adaptive management approach. Using this approach, each restoration is considered an experiment, and monitoring is conducted post-restoration to determine how and where certain restoration approaches are effective. This monitoring is vital, given that there will inherently be spatial and temporal variability among each restoration project that may affect its outcome relative to other projects. Employing adaptive management enables managers to implement improved and tailored restoration methods going forward.

A further lesson learned for buffer protection and restoration was the importance of sufficient preparatory work and conservation planning. For example, programs could conduct localized geographic analyses to strategically target specific locations where buffers would be most beneficial in nutrient load reduction, as this is a cost-effective approach that accounts for the fact that water quality contributions vary at a local scale depending on adjacent land use and other factors (e.g. the amount and direction of subsurface flows) (Chesapeake Bay Program 2013). Datasets are being developed that illustrate concentrated flow paths over high-resolution land use data to prioritize areas for targeted restoration where pollutant and nutrient runoff has the greatest effect on the water body (Allenby and Phelan 2013), and to prioritize areas for targeted protection where there are high-functioning natural landscapes (Allenby and Burke 2012). As an additional planning tool, it is important to recognize that planted buffers may still be susceptible to erosion, especially on steep slopes; engineered structures prepared from large woody debris or geotextile mats and rolls can effectively support planted vegetation (Medina et al. 2016). Furthermore, post-restoration monitoring and adaptive management should be implemented to assess success and control for invasives (Medina et al. 2016). Additionally, programs could consider buffer protection in addition to restoration. Protection is considered by some organizations an easier, more successful, and cost-effective method. To capitalize on previous restoration efforts, buffer protection could be targeted to areas where restoration has been undertaken through public funding. Lastly, a targeted conservation framework should be implemented in state and local laws and ordinances to emphasize the protection of buffers (Chesapeake Bay Program 2013).

The case studies highlighted in this review demonstrate that there may be differences in buffer efficacy and function in environmental settings as compared to the experimental settings from which much of the review's width recommendations are sourced. In general, these case studies raise an important cautionary note that buffers do not represent a panacea in terms of mitigating environmental stressors and providing critical ecosystem services. It is also clear that quantitatively linking the maintenance or restoration of buffers to key services such as water quality outside of an experimental arena can be difficult. The latter issue is not surprising given that well-designed studies invariably involve controlling factors other than those of interest, whereas real-world application of buffers occurs within a highly stochastic, multi-variate, and often un-replicated environment (i.e. "the real world"). The challenge in linking the use of buffers to clear environmental benefits in real-world applications is important to recognize, particularly when communicating with relevant stakeholders. However, it is also vital that we highlight the important evidence drawn from controlled studies in which specific cause-and-effect mechanisms linking buffers to the services they provide have been tested and validated.

Appendix 1.

Literature review summary table of buffer widths for water quality. Reproduced with permission from Rick Van de Poll, Chair, NHANRS Wetland Buffer Scientific Work Group. Color coding corresponds as follows: light gray – wetlands, light blue – streams, dark gray – vernal pools, yellow – ponds less than 10 acres, dark blue – ponds greater than 10 acres.

CITATION TYPE	**AREA OF CONCERN RELATIVE TO WETLAND/RIPARIAN ZONE FUNCTION INTEGRITY**					
Buffer Research Compendia	GENERAL	Sediment	TDS/TSS	Nitrogen	Phosphorus	Organics (e.g. bacteria)
Sweeney & Newbold (2014)	≥ 98 ft.					
Chase, Deming & Latawiec (1995)	≥ 100 ft.					
Sheldon et al. (2005)	≥ 197 ft.	66 – 328 ft.		≥ 66 ft.		
Granger et al. (2005)	40 - 75 ft.					
Wenger (1999)[1]		≥ 98 ft.		≥ 98 ft.	≥ 98 ft.	
Nieber (2011)			≥ 100 ft.	≥ 100 ft.	≥ 100 ft.	
Straughan Environmental Services, Inc. (2003)[2]	82 - 98 ft.					
Sweeney & Newbold (2014)		≥ 98 ft. [3]		≥ 131 ft[4]		
BMP Guides						
Environmental Law Institute (2003)		≥ 82 ft.	≥ 82 ft.	≥ 82 ft.	≥ 82 ft.	
Environmental Law Institute (2008)[5]		30 - 100 ft.		100 - 165 ft.	30 - 100 ft.	30 - 100 ft.
Fischer & Fischenich (2000)	16 - 98 ft.					
deMaynadier et al. (2007)	50 - 330 ft.					
Calhoun & Klemens (2002)	≥ 100 ft.					
deMaynadier et al. (2007)	50 - 400 ft.					
Wenger (1999)[1]		≥ 98 ft.		≥ 98 ft.	≥ 98 ft.	
Fischer & Fischenich (2000)	16 - 98 ft.					
Good Forestry in the Granite State (2010)[3]	≥ 100 ft.					
deMaynadier et al. (2007)	50 - 250 ft.					
deMaynadier et al. (2007)	75 - 125 ft.					
Good Forestry in the Granite State (2010)[3]	100 ft.					
deMaynadier et al. (2007)	100 - 330 ft.					
Good Forestry in the Granite State (2010)[3]	300 ft.					
Journal Articles / Technical Reports						
Murphy & Golet (1998)	≥ 100 ft.					
Schwerr & Clausen (1989)[6]		≥ 98 ft.	≥ 98 ft.	≥ 115 ft.	≥ 115 ft.	
Murphy & Golet (1998)	≥ 100 ft.					
Murphy & Golet (1998)	≥ 150 ft.					
Ahola (1990)	≥ 160 ft.					
Correll & Weller (1989)				≥ 60 ft.		

Peterjohn & Correll (1984)		≥ 60 ft.				
Rhode Island Rivers Council (2005)	≥ 300 ft.					

Additional Information

[1] Wenger also suggests adding 2 ft. for every 1% of slope
[2] Based on 21 papers related to water quality concerns; also recommended 3-zone system: Zone 1: 15 ft. (natural); Zone 2: 60 ft. (managed); Zone 3: 20 ft. (grazed)
[3] Each recommended RMZ suggests a minimum 'no-cut' zone: ponds: 0 ft.; great ponds: 25 ft.; 4th order +: 25 ft.; 3rd order: 50 ft.; 1st & 2nd order: 25 ft.
[4] Median removal rate was 65% for 33 ft. buffer and 85% for 98 ft. buffer for 28 studies of both grass and forest buffer sites
[5] McElfish, Kihlsinger, & Nichols are the principal authors
[6] For removal of > 90% of the pollutant

Appendix 2.

Literature review summary table of buffer widths for hydrologic effects. Reproduced with permission from Rick Van de Poll, Chair, NHANRS Wetland Buffer Scientific Work Group. Color coding corresponds as follows: light gray – wetlands, light blue – streams, dark gray – vernal pools, yellow – ponds less than 10 acres, dark blue – ponds greater than 10 acres.

CITATION TYPE	AREA OF CONCERN RELATIVE TO WETLAND/RIPARIAN ZONE FUNCTION INTEGRITY		
Buffer Research Compendia	GENERAL	Run-Off/Bank Stability	Flood Storage
Granger et al. (2005)	50 - 110 ft.		
Wenger (1999)[1]	33 - 98 ft.		
Straughan Environmental Services, Inc. (2003)[2]	82 - 98 ft.		
Sweeney & Newbold (2014)	≥ 82 ft[3]		
Murphy (N.D.)	100 ft.		
Vermont Agency of Natural Resources (2005)	37 - 225 ft.		
Bolton & Shellberg (2001)[4]			100-yr floodplain
BMP Guides			
Environmental Law Institute (2003)	≥ 98 ft.	≥ 164 ft.	
deMaynadier et al. (2007)	50 - 330 ft.		
Calhoun & Klemens (2002)	≥ 100 ft.		
Wenger (1999)[1]	33 - 98 ft.		
Fischer & Fischenich (2000)	33 - 66 ft.		66 - 492 ft.
Good Forestry in the Granite State (2010)[5]	100 ft.		100-yr flood-plain + 25 ft.
deMaynadier et al. (2007)	50 - 250 ft.		
deMaynadier et al. (2007)	75 - 125 ft.		
Good Forestry in the Granite State (2010)[5]	100 ft.		
deMaynadier et al. (2007)	100 - 330 ft.		
Good Forestry in the Granite State (2010)[5]	300 ft.		
Journal Articles / Technical Reports			
Murphy & Golet (1998)	≥ 100 ft.		
Murphy & Golet (1998)	≥ 150 ft.		
Rhode Island Rivers Council (2005)	≥ 300 ft.		
Additional Information			
[1] Wenger also suggests adding 2 ft. for every 1% of slope [2] Based on 21 papers related to water quality concerns; also recommended 3-zone system: Zone 1: 15 ft. (natural); Zone 2: 60 ft. (managed); Zone 3: 20 ft. (grazed)			

[3] Based on 38 studies in a variety of locales and with variable cover types; median removal rate for this distance was 89%

[4] Applicable for 55% of species; 5 spp. < 100 ft.; 3 spp. 100 - 200 ft.; 9 spp. > 200 ft.

[5] Each recommended RMZ suggests a minimum 'no-cut' zone: ponds: 0 ft.; great ponds: 25 ft.; 4th order +: 25 ft.; 3rd order: 50 ft.; 1st & 2nd order: 25 ft.

Appendix 3.

Literature review summary table of buffer widths for habitat for biodiversity. Reproduced with permission from Rick Van de Poll, Chair, NHANRS Wetland Buffer Scientific Work Group. Color coding corresponds as follows: light gray – wetlands, light blue – streams, dark gray – vernal pools.

CITATION TYPE	AREA OF CONCERN RELATIVE TO WETLAND/RIPARIAN ZONE FUNCTION INTEGRITY							
Buffer Research Compendia	GENERAL	Aquatic Macro-Invertebrate	Amphibian	Reptile	Fish	Waterfowl	Passerine Bird	Mammal
Chase, Deming & Latawiec (1995)	100 - 300 ft.							
Boyd (2001)[1]			≥ 200 ft[2]	≥ 200 ft[3]		≥ 200 ft[4]	< 200 ft[4]	≥ 200 ft[5]
Desbonnet et al. (1994)	246 - 1,969 ft.							
Sheldon et al. (2005)			384 - 673 ft.				≥ 328 ft.	≥ 328 ft.
Granger et al. (2005)		≥ 100 ft.	390 - 1900 ft.	440 – 3,700 ft.	≥ 100 ft.		390 – 2,000 ft.	250 - 650 ft.
Wenger (1999)[6]	≥ 328 ft.							
Nieber (2011)	500 - 950 ft.							
Sweeney & Newbold (2014)	≥ 98 ft. [7]		≥ 98 ft.					
Murphy (N.D.)		100 ft.			100 ft.			
Vermont Agency of Natural Resources (2005)	10 - 840 ft.							
Lichtin (2008)	50 - 200 ft.							
Bolton & Shellberg (2001)[4]	150 - 250 ft.							
BMP Guides								
Bentrup (2008)		100 - 200 ft.	100 - 600 ft.	100 - 600 ft.		100 - 330 ft.	200 ft. - 5,280 ft.	100 - 330 ft.
Environmental Law Institute (2003)	≥ 328 ft.	≥ 328 ft.						
Environmental Law Institute (2008)[8]	100 - 950 ft.							
Calhoun & Klemens (2002)	100 - 750 ft.							
Bentrup (2008)		100 - 200 ft.	100 - 600 ft.	100 - 600 ft.				
U.S. Army Corps of Engineers (2015)	100 - 750 ft.							
Wenger (1999)[6]	≥ 328 ft.							
Fischer & Fischenich (2000)	98 - 1,640 ft.							
Good Forestry in the Granite State (2010)[9]	≥ 300 ft.				≥ 150 ft.			

Journal Articles / Technical Reports								
Groffman et al. (1991)	≥ 328 ft.						≥ 328 ft.	
Kiviat (1997)				3,281 ft[10]				
Semlitsch & Bodie (2003)			522 - 951 ft.	417 - 948 ft.				
Harper et al. (2008)	328 - 541 ft.		328 - 541 ft.					
Rabeni (1991)			25 - 200 ft.		25 - 200 ft.	25 - 200 ft.		
Brown et al. (1990)	300 - 600 ft.							

Additional Information

[1] Based on 9 reptiles, 19 amphibians, 14 mammals, and 23 birds that were identified as "wetland dependent"

[2] Applicable for 58% of species; 1 species 100-200 ft.; seven species < 100 ft.

[3] Applicable for 67% of species; 1 species < 100 ft.; 2 species < 35 ft.

[4] Applicable for 55% of species; 5 spp. < 100 ft.; 3 spp. 100 - 200 ft.; 9 spp. > 200 ft.

[5] Applicable for 80% of species; 2 species found to be within 100 ft.

[6] Wenger also suggests adding 2 ft. for every 1% of slope

[7] For the maintenance of stream bank and stream channel width integrity

[8] McElfish, Kihlsinger, & Nichols are the principal authors

[9] Each recommended RMZ suggests a minimum 'no-cut' zone: ponds: 0 ft.; great ponds: 25 ft.; 4th order +: 25 ft.; 3rd order: 50 ft.; 1st & 2nd order: 25 ft.

[10] Applicable only to Blanding's turtles

Appendix 4.

Summary of knowledge gaps and research needs identified through the compilation of this literature review.

- A literature review examining the extent to which human activity has degraded water resources post-colonization, and what quantity of these resources are needed to retain functioning ecosystem services in a sustainable manner for both humans and biodiversity.
- Research that illustrates the effects of having no buffer on a water body, and the associated percent of nutrient and contaminant inputs that enter the water body.
- Calculable functional relationships between buffer width and amount of pollutant reduction.[1]
- Controlled studies to determine how various buffer characteristics (e.g. vegetative composition, stem density, canopy cover) affect buffer function.
- Robust models estimating flood storage capacity based on buffer width and other important attributes, including basin geomorphology and soil type.
- Robust models estimating run-off reduction and effective bank stability based on buffer width and other important attributes, such as slope and soil type.
- Robust models estimating how buffer width affects the amount of surface water infiltrated.

[1]This ability to link buffer restoration or protection to a specific amount of nutrient reduction is a vital step in helping to promote the use of green infrastructure in meeting water quality improvements. Despite the research need, the University of New Hampshire's Stormwater Center is making progress on this front through its NHDES Pollutant Tracking and Accounting Pilot Project, which will identify potential tools to enable municipalities to quantitatively assess nonpoint source pollutant load reductions in the GBE.

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Buffer Options for the Bay:
Exploring the Trends, the Science, and the Options of Buffer Management in the Great Bay Watershed

Key Findings from Economic Literature

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A. Overview

In New Hampshire, the need for trusted, relevant science is experienced at every scale of buffer management, from decisions made by property owners at the water's edge to those of state agencies setting policy for what's permissible on that land. Underpinning each decision is a series of tradeoffs that reflect assumptions held about the impact of that choice on the environment, the economy, and the well-being of the community. This review seeks to support these decisions by presenting a synthesis of available economic and other social science literature on the subject of buffer values and management for the Great Bay Estuary (GBE) and its tributaries in southeast New Hampshire.

The review was commissioned by the Buffer Options for the Bay ("BOB") technical team, which is a component of the larger integrated assessment BOB project entitled "Exploring the Trends, the Science, and the Options of Buffer Management in the Great Bay Watershed." This project is a grant-sponsored collaboration of public, academic, and nonprofit organizations dedicated to enhancing the capacity of New Hampshire stakeholders to make informed decisions that support the protection and restoration of buffer lands in the GBE region. The project defines buffers as naturally vegetated segments of land directly upslope of a water resource, such as a lake, stream, river, pond, estuary, or other wetland type.

In keeping with this goal, this review has been inspired by typical questions that arise in the course of local buffer management. For example, what economic values are associated with ecosystem services provided by buffers? How much are people "willing to pay" to maintain or avoid loss of these services? What role do buffers play in enhancing property values? What economic costs arise in buffer management? What lessons can we learn from previous benefit-cost analyses? What are the economic aspects of buffer-related policy options and how might they influence landowner, land trust, resource manager, and regulator decision making?

This review found that, in general, vegetative buffers have two opposing effects on property values. Improved ecosystem service provisioning may increase prices for adjacent and nearby properties. In contrast, lost development potential and degraded scenic views may reduce prices. Economic theory does not provide any guidance on which effect will dominate and, thus, it is not surprising that studies investigating the effect of vegetated buffers on housing prices have produced mixed results.

In comparison, the general consensus of relevant literature on water quality is that it has a definite effect on property prices, whereby higher property values are associated with better water quality. In addition, these positive effects, which can be as high as a 30 percent increase in property value, extend far beyond waterfront properties, although they diminish as distance from the water body increases. While this literature review is mainly focused on economic values of households living within close proximity of the focal resource, it is worth noting that additional benefits of buffer-related ecosystem services accrue to visiting recreationists and other tourists.

The spatial mismatch between buffer management benefits and costs often complicates their management. Buffers are relatively small from a landscape- or watershed-scale perspective and often located on private land with management costs typically incurred by individual landowners. In contrast, most buffer-generated benefits (e.g., water quality and fish habitat) reach well beyond parcel boundaries to other beneficiaries. In most instances, the landowner is unable to exclude others from receiving the ecosystem services provided by buffers and, thus, cannot demand payment for these benefits. As a result, waterfront landowners will likely undersupply (in terms of both quantity and quality) buffers.

To address this distributional issue, societies can establish policies, programs, or institutions that align the interests of private landowners with social interests. In some cases, this involves governments regulating landowner behavior (e.g., establishing buffer rules), forcing landowners to bear management and opportunity costs. In other cases, government agencies or nonprofits offer incentives to landowners to facilitate provisioning of the socially efficient amount of buffer-provided ecosystem services.

Untargeted buffer regulations, while administratively straightforward, could generate large costs for landowners. Although there are several ways to target land-use regulations and reduce overall opportunity costs, increases in regulatory flexibility to address ecological heterogeneity often create higher administrative costs. That is, a tradeoff exists between the opportunity costs to landowners and the transaction and management costs to the regulator, and it may be unclear which approach minimizes the total cost burden to society.

In comparison, targeted payments for ecosystem services can be made to landowners as incentives to: engage in some activity or group of activities (e.g., installing vegetated buffers) that maintain, restore, or improve the provision of one or more ecosystem services; reduce the intensity of active land uses (e.g., building fewer homes); or cease destructive land use altogether. Payments can be monetary or in-kind and can come from government agencies, nonprofit organizations (e.g., land trusts), or the direct beneficiaries. Purchased conservation easements are one way of targeting critical buffers. Payments can also come in the form of tax credits or deductions. For example, New Hampshire's Current Use Taxation Program allows property taxation at lower "traditional use" values rather than the real estate market value. A similar tax credit program for buffer areas might provide good incentives to waterfront landowners in the Great Bay watershed.

The efficacy of different buffer management policies is case-dependent and influenced by the specific ecosystem services of interest, the level of landscape connectivity required to provide the targeted services, and the magnitude and distribution of benefits and costs. If the number of landowners needed for conservation success is low and buffers providing high-quality ecosystem services can be easily targeted, then incentive-based approaches (e.g., easements and payments for ecosystem services) may work better. If many landowners need to be involved, then simple and non-targeted approaches (e.g., buffer regulations and public education) may be more appropriate. Economic incentives that reduce land-use intensity, rather than eliminating all land uses, cost less and are much more likely to fall within organizations' conservation budgets. Community attitudes towards conservation can influence the dominant property rights regime that ultimately determines who incurs what cost. Sharing the cost burden among landowners and the rest of society may result in higher total costs, but may provide more equitable (and perhaps more politically feasible) alternatives.

Several gaps in our current understanding of the economics of buffer management were uncovered through this review. First, while there is substantial literature covering the effects of water quality on property values, there are very few empirical analyses of the effects of the physical buffer itself. Anecdotal evidence provided mixed results, suggesting that some waterfront landowners enjoy the privacy of a densely vegetated buffer while others prefer an unobstructed view of the water body. Second, only two case studies of New Hampshire residents could be found, both of which were conducted using lakefront property sales data from the early 1990s. As a result, the Buffer Options for the Bay project has been forced to extrapolate willingness to pay values from other diverse locations. Third, no studies comparing a full set of benefits and costs associated with buffer management could be located and existing benefit-cost analyses were highly inconclusive. Finally, no studies that compared the economic and ecological outcomes of buffer regulations to outcomes of other buffer policies were found. This has ramifications for the efficiency of long-term buffer planning and management.

The economic research synthesized in this document is intended to be used by the Buffer Options for the Bay (BOB) project team, though the explicit intent is to then create a number of informational products that translate this science into a more accessible form for end users. Ultimately, the products that are shaped from this review will be of service to all buffer management stakeholders in the Great Bay region, including landowners and the consultants who work with them, regulatory agencies and municipalities, conservation organizations and foundations, and scientists interested in conducting research that will lead to more effective buffer management.

Economics, however, is only one piece of the buffer management puzzle. To augment this economic literature review, the BOB collaborative has conducted a review of the natural science aspects of buffer management, an analysis of regulatory and non-regulatory policy options for New Hampshire, an economic analysis of the values placed on the water quality benefits provided by buffers, a buffer-focused GIS analysis of the GBE region, and an assessment of the barriers and opportunities related to buffer management at the community level in the Exeter-Squamscott subwatershed.

The results of these analyses have been captured in individual reports. They have also been integrated into an online framework intended to inform discussions around buffer management, restoration, and protection in the GBE region. We anticipate that this website will open the door to new and needed research; strategic and complementary investments by state agencies, nonprofits, and foundations; and a collective strategy for outreach professionals to work with communities on advancing effective buffer policy and practice at the local level.

B. What are the economic benefits and costs of buffer management?

Buffers provide many valuable ecosystem services including water purification, wave and storm surge protection, and wildlife habitat. However, intensive land uses (e.g., conversion to residential and commercial development) threaten the continual provisioning of these services in part because the ecosystem services provided by buffers are not bought and sold through formal markets, and traditional economic analyses often ignore them. Quantifying the values of ecosystem services in monetary units can assist in land-use and buffer management decision making. This section synthesizes the existing literature reporting on economic benefits and costs of buffer preservation, restoration, and ongoing management. The section begins with a look at the benefits that accrue to households, with a particular focus on the effects of buffers on residential property values. Information on these values may incentivize private landowner stewardship behavior including voluntary buffer management. This section then investigates the various costs associated with maintaining or improving the quantity and quality of buffers. Examining both the magnitude and the distribution of all costs is important. Finally, this section concludes with an exploration of studies that conduct benefit-cost analyses (BCAs) in order to discover lessons that may be applicable to managing buffers in the Great Bay watershed.

I. What economic values are associated with ecosystem services provided by buffers?

Non-market valuation methods developed over the past few decades can be used to quantify the benefits and costs associated with the goods and services provided by nature and not sold in traditional markets in order to improve decision making regarding their use and conservation. Two of these methods are commonly used to assess the values of ecosystem services accruing to households within the local community, county, or watershed. The first—contingent valuation or discrete choice survey—is a stated-preference technique that uses responses to hypothetical scenarios to estimate household willingness to pay (WTP) for potential future programs or policies that would improve environmental quality. A small number of WTP survey studies focused on buffer management have been conducted as part of larger BCAs and are discussed later. Two additional stated-preference studies investigating public WTP for full stream restoration—Collins et al. (2005) studied the restoration of Deckers Creek in West Virginia, while Weber and Stewart (2009) studied the restoration of the Middle Rio Grande in New Mexico—found strong support for projects that include buffer restoration ($50 to $150 per household per year), although specific values for buffers were not estimated.

The second non-market valuation method—hedonic property pricing—is a revealed-preference technique that breaks down the price of a property into a set of implicit prices for building characteristics (e.g., number of bedrooms), parcel attributes (e.g., parcel size), community characteristics (e.g., school quality), and environmental amenities (e.g., scenic views) of the parcel and surrounding neighborhood. The next two sections report on hedonic studies that assess the effects of vegetated buffers and water quality on residential property prices.

While this literature review is mainly focused on economic values of *households* living within local communities, counties, or watersheds of the ecological resource, it is worth noting that additional benefits of buffer-related ecosystem services accrue to visiting recreationists and other tourists (Phaneuf et al. 2008, Colby and Smith-Incer 2005, Colby and Orr 2005, Lipton 2004). These values are not covered in this review, but could be substantial in some locales. Further, additional benefits (or costs) may accrue to communities, due to changes in property tax revenues; these are discussed later in the policy section of this review.

i. Effect of vegetated buffers and riparian restoration on residential property prices

In general, vegetative buffers can have two opposing effects on property values. Improved water quality, fish and other wildlife habitat, stream bank stabilization, and overall aesthetics of the surrounding environment may increase prices for adjacent and nearby properties. In contrast, lost development potential and degraded scenic views (e.g., hidden water) may reduce prices. Economic theory does not provide any guidance on which effect will dominate and, thus, it is not surprising that studies investigating the effect of vegetated buffers on housing prices have produced mixed results ranging from a 27 percent gain to a 5 percent loss, depending on geographic region, location of property (e.g., waterfront vs. non-waterfront), and whether public access is allowed (Table 1). While no hedonic buffer studies were found for New Hampshire, several other studies provide good insights for the Great Bay watershed. Of the ten studies examined, the two studies that examined the impact of mandatory buffer rules both found no price effect. Five studies report positive price effects, but three of these are for public greenways rather than vegetated buffers on private lands. Of the remaining three studies, one reports negative price effects, and two report mixed effects depending on the location of the property.

Bin et al. (2009) examined the impact of a mandatory buffer rule on riparian properties in the Neuse River Basin (Craven County, North Carolina) using housing sales data from before and after the rule went into effect. The rule requires a 50-foot riparian buffer with undisturbed forest vegetation in the first 30 feet and shrubs and other plants in the remaining 20 feet. They found that, while waterfront properties are on average 25.9 percent higher priced than otherwise equivalent non-waterfront properties, there was no significant difference between waterfront housing prices before and after the buffer rule (i.e., the buffer regulation had no impact on house prices). The authors suggest that the lack of impact may be due to the lost development opportunities of waterfront landowners being balanced out by the amenity benefits received by all nearby property owners. Alternatively, they also suggest that the rule may not have been binding because the land in buffers was not buildable buildable and many waterfront properties already maintained a vegetated buffer meeting the requirements of the regulation. A similar "no effect" result was found by Maurer and Soldavini (2013) who investigated the impact of mandatory riparian ordinances on residential property values in Jackson County, Oregon.

In comparison, Mooney and Eisgruber (2001) found a negative effect of planting treed riparian buffers on waterfront properties in the Mohawk Watershed of western Oregon. While waterfront properties had a premium price 10 percent higher than equivalent non-waterfront properties, the planting of a treed riparian buffer reduced the values of waterfront properties by 0.33 percent per foot if the buffer width was less than or equal to 30 feet or by 0.07 percent per foot if the buffer width exceeded 30 feet. For an average waterfront property in the region, a new 50-foot treed buffer (i.e., assuming no treed buffer as the baseline) would result in an 11 percent reduction in market value. The authors suggest that the dense vegetation diminished the view of the river in a region where trees are abundant.

Similarly, Münch et al. (2016) found a negative price effect of a ten-meter buffer on properties with the buffer in two rural municipalities in Denmark. However, non-buffer properties nearby incur a positive price effect, which increases the closer the property is to a public access point in the buffer zone (rather than a direct line distance to the buffer). That is, public access to the protected area is key to achieving positive price effects. This case study is an interesting illustration of the potential distributional effects that can result from mandatory buffers, whereby the owners of the buffer properties incur the costs of lost productive use of their lands, while nearby residents gain the positive recreational and other amenities.

In contrast, Streiner and Loomis (1995) examined the impact of seven urban buffer restoration projects on property values in three California counties (Contra Costa, Santa Cruz, and Solano), and found that property values in areas near the improved streams increased by 3 to 13 percent depending on the specific restoration activities (e.g., stream bank stabilization, flood reduction, improved fish habitat). While distance to the stream was significant (i.e., higher values for properties closer to the stream), the authors did not distinguish between waterfront and non-waterfront properties.

Qiu et al. (2006) also found positive effects of streams and related open space on suburban property values in the Dardenne Creek watershed near St. Louis, Missouri. Properties containing the stream and/or related open space *could* incur a price premium as much as 4 percent. Nearby properties *could* also receive higher prices, although the premium fell as distance from the stream increased. The novelty of this study is that it pointed out that not all properties would necessarily receive the price premium, as properties within a flood zone could drop as much 4.7 percent, leading to a potential overall loss in value when accounting for both effects.

Similarly, Hamilton and Quayle (1999) found positive impacts of riparian greenways on property values in four suburban neighborhoods around Vancouver and Victoria, British Columbia. Price premiums varied from 11.9 to 15.6 percent for properties adjacent to the greenways. No price effect was found for non-adjacent, nearby properties. In this study, the greenways are publicly-owned riparian zones, so private properties are not directly adjacent to the waterway. A related survey of households in the four areas revealed that 75 percent thought the greenway increased their property value with an average impact of 20.6 percent (higher than the statistically estimated actual effect), 67 percent “felt a sense of collective ownership,” and amenities ranked in order of preference were recreation, flood control, and wildlife preservation. Bark-Hodgins et al. (2005) and Colby and Wishart (2002) also report positive values for nearby vegetative riparian areas in semi-arid Tucson, Arizona, where vegetation of all kinds is in short supply.

In a slightly different analysis, Netusil (2006) examined the effect of riparian *corridor* quality on property values in the Fanno Creek Watershed in Portland, Oregon. Corridor refers to the waterway *and* the surrounding land. In one model specification, which measured corridor quality with a riparian functional score (based on microclimate, bank stabilization, sediment and pollution control, streamflow, water storage, woody debris, and channel dynamics), properties containing riparian buffers experience a positive 4.7 percent price increase for a one standard deviation increase in the riparian score. In a second model specification, which measured corridor quality using a three-class ecological system, properties containing Class I (the highest quality) riparian buffers experienced positive (although not statistically significant) price effects, while properties containing Class II or Class III riparian buffers experienced negative price effects (although only the Class II effect was statistically significant).

Table 1. Comparison of property price effects due to adjacent or nearby riparian buffers.

Study	Location	Water Body	Buffer Metric	Price Effect*
Bark-Hodgins et al. 2005	Arizona (Tucson area)	urban streams	densely-vegetated riparian corridor	20%
Bin et al. 2009	Craven County, North Carolina	Neuse River	50-foot buffer requirement	no effect
Colby and Wishart 2002	Arizona (Tucson area)	urban streams	densely-vegetated riparian corridor	10% to 27% depending on distance to corridor
Hamilton and Quayle 1999	Vancouver and Victoria, British Columbia	suburban streams	riparian greenways (public access vegetated buffers)	11.9% to 15.6% adjacent properties; no effect elsewhere
Maurer and Soldavini 2013	Jackson County, Oregon	Rogue River and tributaries	75-foot for river, 50-foot for streams	no effect
Mooney and Eisgruber 2001	Western Oregon	Mohawk Watershed	variable-widths (mean 30-foot), treed riparian buffer	-0.33% per buffer foot for width ≤30 feet; -0.07% per buffer foot for width >30 feet; -11% of sales price for average property with 50-foot buffer
Münch et al. 2016	Denmark (two rural regions)	rivers, streams, and lakes	10-meter buffer zone	negative effect on buffer properties, positive effect on non-buffer properties
Netusil 2006	Portland, Oregon	Fanno Creek Watershed	riparian function score	4.7% for a one standard deviation increase in riparian score
Qiu et al. 2006	St. Charles County, Missouri	Dardenne Creek Watershed	stream with buffer/open space	4% decreasing as distance increases; -4.7% if in floodplain
Streiner and Loomis 1995	California (three counties)	urban streams	riparian buffer restoration projects	3% to 13% depending on restoration activities

*Price effects shown as percent increases or decreases in the mean house sales price unless otherwise specified.

ii. Effect of water quality on residential property prices

A number of hedonic property price studies estimating the effect of water quality on residential property prices have been conducted over the past 30 years (Table 2). While these studies include different geographic regions and a variety of water quality metrics (e.g., water clarity, pollutant concentrations, indicator species), the general consensus is that water quality has a definite effect on property prices whereby higher property values are associated with better water quality. In addition, these positive effects—ranging from less than 1 percent to 30 percent increases—extend beyond waterfront properties, although they diminish as distance from the water body increases. Reductions in water quality also affect property prices.

Two hedonic water quality studies were conducted in New Hampshire. In the first, Gibbs et al. (2002) examined the effect of water clarity (measured by secchi disk visibility depth) on sales prices of waterfront properties on 69 public access lakes across 59 communities. Results showed that house prices were higher on lakes with better water quality, and that estimated implicit prices varied among four New Hampshire regions, likely due to variations in average water clarity, lake area, and housing markets: $1,135 per meter in Conway/Milton, $3,923 per meter in Derry/Amherst, $5,541 per meter in Winnipesaukee (but not including properties on Lake Winnipesaukee, which is much larger than other lakes), and $9,756 per meter in Spofford/Greenfield. (All prices above are in 1995 U.S. Dollars (USD) per meter of additional visibility.) Using the mean house price in each region, these implicit prices can be converted to a percent increase in average sales price of 0.91, 3.39, 3.50, and 6.64 percent, respectively, for a one-meter increase in secchi disk depth.

In the second New Hampshire study, Halstead et al. (2003) investigated the effects of an invasive species (water milfoil) on lakefront property values. Milfoil can spread at exponential rates, limiting boating and swimming activities, crowding out native plants essential for fisheries, and reducing overall aesthetics. Results showed extensive losses in property values (20 to 40 percent) due to the presence of milfoil in the lake, although even the authors note that these results may be inconclusive due to the relatively simple metric used (presence/absence of milfoil at the lake scale). In addition, other researchers questioned their use of ordinary least squares (OLS) statistical methods (Horsch and Lewis 2009). However, several more recent studies using different metrics and statistical approaches corroborate the negative effect of milfoil on property values, although the magnitude of the losses is less, ranging from 8 to 24 percent (Tuttle and Heintzelman 2015, Zhang and Boyle 2010, Horsch and Lewis 2009). Additional insights for the Great Bay watershed can be found in other studies conducted outside New Hampshire.

Walsh et al. (2011) found that while waterfront properties have positive implicit prices for water clarity improvements (1.25 percent increase in the mean house price for a one-foot increase in visibility), non-waterfront properties also have positive implicit prices with prices decreasing as distance from the lake increases from a 0.73 percent increase for homes 100 meters from the lakeshore to a 0.18 percent increase for homes 1000 meters from the lakeshore. Although the effect of water clarity is greater for waterfront properties, the much larger number of non-waterfront properties allows for aggregate benefits from non-waterfront properties to be a substantial portion of total benefits (50 to 80 percent in their examples). Tuttle and Heintzelman (2015) and Walsh et al. (2017) also show positive implicit prices for water quality extending beyond waterfront properties in Adirondack Park (New York) and counties around the Chesapeake Bay (Virginia), respectively.

In one of the earlier water quality hedonic property studies, Epp and Al-Ani (1979) found that when water quality is low, the effects of other property characteristics are larger. For example, the effect of flood hazard (i.e., the potential for flooding) on prices was insignificant for properties on streams with good water quality but was significantly negative for properties on streams with poor water quality.

The choice of environmental quality metrics to use in hedonic property valuations is important and should ideally be suited to the ultimate use of estimated economic values. Michael et al. (2000) examined nine different water quality metrics, all based on secchi disk readings, to explore the effect of short-term versus long-term measures on property prices. In particular, they investigate whether home buyers care more about current water quality conditions versus expectations about future conditions, and whether they consider historical conditions as representative of future trends. Results were mixed, suggesting that different property owners may perceive water quality in different ways. Walsh et al. (2017) also found mixed results (i.e., positive and negative implicit prices for water quality) when using three-year water quality averages versus all positive values when using one-year averages.

In another comparison of alternative water quality metrics, Walsh et al. (2016) show that a three-nutrient composite Trophic State Index (TSI), including total nitrogen, total phosphorus, and chlorophyll-a, performs better than each of the single-nutrient measures as well as a one-out, all-out (OOAO) composite indicator, in large part due to the way the TSI encompasses physical conditions and controls for nutrient-limiting threshold situations. Single-nutrient metrics may overestimate economic values by an order of magnitude, which can be critical if conducting a full benefit-cost analysis or making policy decisions.

Bin and Czajkowski (2013) compared the use of technical measures of water quality (water clarity, salinity, pH, and dissolved oxygen) against the use of non-technical measures (percent and letter "grades") thought to be more intuitive to the general public. Their results showed that the technical measures were better predictors of house prices, indicating that waterfront homebuyers in the study area (Martin County, Florida) are "relatively sophisticated" in their understanding of technical water quality issues. However, the authors suggest that these homebuyers may have acquired this knowledge by going through the process of interpreting the grades from the underlying technical metrics used to calculate them.

In a similar study, Poor et al. (2001) compared an objective scientific metric of water clarity (i.e., secchi disk depth) with individual subjective perceptions of water clarity obtained through a mail survey in which new lakefront home buyers were asked to rate the minimum water clarity of the lake during the first summer they owned the property. Results showed that most (61 percent) respondents in four regions of Maine underestimated water clarity by more than one foot, while another substantial group (23 percent) overestimated water clarity by more than one foot. Only 16 percent of respondents were able to accurately estimate water clarity within one foot of its scientifically monitored and reported depth. Thus, concerns about the use of objective scientific measures in hedonic property analyses may be unfounded and the use of subjective measures may lead to substantial over-or under-valuation of the environmental amenity.

A number of studies investigated the impact of the recent economic recession (2007–2009) on implicit prices for water quality and other environmental amenities. Bin et al. (2016) found that the recession had no effect on water quality values (implicit prices) for sales of waterfront homes in Martin County, Florida-- a result that may be due to the relative wealth of homebuyers in this study (mean house sale price of $810,000). In contrast, Cho et al. (2011) found a reduction in implicit prices for other environmental amenities during the recession. Specifically, the value of developed and forested open space within a one-mile radius of the property fell from 6.16 to 4.26 percent and from 4.42 to 2.41 percent of the mean housing price, respectively, for homes in Nashville-Davidson County, Tennessee. They also found that while implicit prices for a water view fell from $52,348 to $45,923 in dollar amounts, they rose slightly when calculated as a percentage of the mean housing price (from 23 to 23.5 percent) because the mean housing price of homes with a water view fell more than the value of the water view. Hillard (2015) also found a negative impact of the recession on implicit prices for water resource amenities for house sales in Duval County, Florida, and showed that this effect increased for properties farther away (that is, waterfront properties lost less value than non-waterfront properties).

While the majority of hedonic water quality studies focus on surface waters, Guignet et al. (2016) examined the impact of *groundwater* quality on residential property values in Lake County, Florida. Results show that finding contamination in private wells within three years prior to the sale will reduce the price by 3 to 6 percent. As the time between finding contamination and sale increases beyond three years, the reduction in price diminishes and gradually approaches zero. While the case study takes place in a region dominated by agricultural runoff, the concern for groundwater contamination may also be relevant for residential properties with private wells in the Great Bay watershed.

Table 2. Comparison of property price effects due to changes in water quality in adjacent or nearby water bodies.

Study	Location	Water Body	Quality Metric	House Type	Price Effect*
Artell 2014	Finland	lakes, rivers, and Baltic Sea	water usability index incorporating 15 ecological and chemical criteria into five water usability classes	waterfront lots (land only)	19-30% for excellent 9-13% for good -9 to -14% for passable -65 to -69% for poor relative to the satisfactory class
Bin et al. 2016	Martin County, southern Florida	St. Lucie River, St. Lucie Estuary, Indian River Lagoon	composite grade (visibility, pH, salinity, dissolved oxygen)	waterfront	0.2% for 1% increase in grade
Bin and Czajkowski 2013	Martin County, southern Florida	St. Lucie River, St. Lucie Estuary, Indian River Lagoon	water visibility, composite grade (visibility, pH, salinity, dissolved oxygen)	waterfront	3.8% and 4.6% for a 1% increase in visibility and grade, respectively
Cary and Leftwich 2007	Greenwood County, South Carolina	Lake Greenwood	algae bloom, chlorophyll-a	within 1000 feet of lake	No significant price effect for either water quality metric
Clapper and Caudill 2014	Near North Ontario ("cottage country" north of Toronto)	74 lakes	water clarity (secchi disk depth)	waterfront and non-waterfront cottages	2.0% for a one-foot increase in visibility
Epp and Al-Ani 1979	Pennsylvania	small rivers and streams	pH	waterfront	6.0% for a one-point increase in pH
Halstead et al. 2003	New Hampshire	10 lakes in central N.H.	invasive species (milfoil) presence/absence	waterfront	20.7% - 42.7% reduction due to presence of milfoil (but statistically inconclusive)

Table 2 Continued. Comparison of property price effects due to changes in water quality in adjacent or nearby water bodies.

Study	Location	Water Body	Quality Metric	House Type	Price Effect*
Artell 2014	Finland	lakes, rivers, and Baltic Sea	water usability index incorporating 15 ecological and chemical criteria into 5 water usability classes	waterfront lots (land only)	19-30% for excellent 9-13% for good -9 to -14% for passable -65 to -69% for poor relative to the satisfactory class
Bin et al. 2016	Martin County, southern Florida	St. Lucie River, St. Lucie Estuary, Indian River Lagoon	composite grade (visibility, pH, salinity, dissolved oxygen)	waterfront	0.2% for 1% increase in grade
Bin and Czajkowski 2013	Martin County, southern Florida	St. Lucie River, St. Lucie Estuary, Indian River Lagoon	water visibility, composite grade (visibility, pH, salinity, dissolved oxygen)	waterfront	3.8% and 4.6% for a 1% increase in visibility and grade, respectively
Cary and Leftwich 2007	Greenwood County, South Carolina	Lake Greenwood	algae bloom, chlorophyll-a	within 1000 feet of lake	No significant price effect for either water quality metric
Clapper and Caudill 2014	Near North Ontario (“cottage country” north of Toronto)	74 lakes	water clarity (secchi disk depth)	waterfront and non-waterfront cottages	2.0% for a one-foot increase in visibility
Epp and Al-Ani 1979	Pennsylvania	small rivers and streams	pH	waterfront	6.0% for a one-point increase in pH
Halstead et al. 2003	New Hampshire	10 lakes in central N.H.	invasive species (milfoil) presence/absence	waterfront	20.7% - 42.7% reduction due to presence of milfoil (but statistically inconclusive)

Table 2 Continued. Comparison of property price effects due to changes in water quality in adjacent or nearby water bodies.

Study	Location	Water Body	Quality Metric	House Type	Price Effect*
Horsch and Lewis 2009	Vilas County, Wisconsin	172 lakes	invasive species (milfoil) presence/absence	waterfront	8% reduction of average property values due to the invasion of one more lake
Gibbs et al. 2002	New Hampshire (four market areas)	69 public access lakes in 59 towns	water clarity (secchi disk depth)	waterfront	0.91% - 6.64% for a one-meter increase in visibility
Kashian et al. 2006	Delavan, Wisconsin (north of Chicago, Illinois)	Delavan Lake	water clarity (secchi disk depth)	waterfront and non-waterfront	2.8% - 11.7% for a one-foot increase in visibility
Leggett and Bockstael 2000	Anne Arundel County, Maryland	Chesapeake Bay	fecal coliform	waterfront	1.3% - 2.6% for a decrease of 100 fecal coliform colonies per 100 mL
Michael et al. 2000	Maine (three market areas)	22 lakes in 39 towns	water clarity (secchi disk depth)	waterfront	5.2% - 10.4% Area 1 1.9% - 3.4% Area 2 14.2% - 28.4% Area 3 for a one-meter increase in visibility
Netusil et al. 2014	Portland, Oregon, metropolitan area	Johnson Creek watershed (Columbia River)	dissolved oxygen (DO), fecal coliform, pH, stream temp., total organic solids	waterfront and non-waterfront within 1 mile	3.12 - 13.71% for a 1 mg/L increase in DO depending on distance from stream
Netusil et al. 2014	Vancouver, Washington, metropolitan area	Burnt Bridge Creek watershed (Willamette River)	dissolved oxygen (DO), other metrics tested	waterfront and non-waterfront within 1 mile	0 - 4.49% for a 1 mg/L increase in DO depending on distance from stream
Poor et al. 2001	Maine (four market areas)	lakes and ponds	water clarity (secchi disk depth)	waterfront	3% - 6% for a one-meter increase in visibility

Table 2 Continued. Comparison of property price effects due to changes in water quality in adjacent or nearby water bodies.

Study	Location	Water Body	Quality Metric	House Type	Price Effect*
Poor et al. 2007	St. Mary's County, southern Maryland	St. Mary's River watershed (Chesapeake Bay)	total suspended solids (TSS), dissolved inorganic nitrogen (DIN)	waterfront and non-waterfront in local watershed	$1086 for a 1 mg/L decrease in TSS, $17,642 for a 1 mg/L decrease in DIN (2003 USD)
Ramachandran 2015	Barnstable County, Massachusetts	Three Bays watershed	nitrogen	waterfront and non-waterfront	0.41% - 0.61% for a 1% decrease in nitrogen (mg/L)
Steinnes 1992	Northern Minnesota	53 lakes	water clarity (secchi disk depth)	land only (no house)	$206 increase in value of lot for a one-foot increase in visibility
Tuttle and Heintzelman 2015	Adirondack Park, New York	52 lakes	pH, loon presence, loon abundance, invasive species (milfoil) presence of nearest lake	waterfront and non-waterfront	-18% (all homes) to -24% (waterfront) for a pH<6.5 (acidic) 11% for loon presence year of sale 1% for each loon present year of sale -6% for presence of milfoil year of sale
Walsh et al. 2017	14 Maryland Counties	Chesapeake Bay	water clarity (light attenuation)	waterfront and non-waterfront within 2000 meters of bay	0.3% - 1.6% waterfront 0.2% - 0.6% 500m for a 10% decrease in light attenuation (4-10cm increase in visibility)
Walsh et al. 2011	Orange County (Orlando), Florida	146 natural lakes	water clarity (secchi disk depth)	waterfront and non-waterfront within 1000 meters of lake	1.25% lakefront, 0.36% (0.18-0.73%) non-lakefront for a one-foot increase in visibility
Zhang and Boyle 2010	Rutland County, Vermont	4 lakes and 1 pond	invasive species (milfoil) and total macrophyte extent (percent cover) in front of property	waterfront homes and unimproved land	-0.3% for just over 1% coverage -16.4% for 80-100% coverage

*Price effects shown as percent increases in the mean house sales price resulting from an increase in water quality. Price effects shown in dollar amounts represent the implicit price of water quality for the house with the mean sale price.

II. What economic costs arise in buffer preservation, restoration, and management?

Management of water quality, wildlife habitat, and other buffer-generated ecosystem services requires substantial monetary or in-kind investments that can be as small as "free" technical assistance and as large as outright purchase of large swaths of land. While their relatively small size might lead one to believe that buffer preservation, restoration, and management will be less costly than conservation via large-scale protected areas, it is important to consider all costs that might be encountered through various buffer programs and policies so that management goals can be achieved at the lowest possible cost. It is also important to consider who incurs the burden of these costs, private landowners or the public (e.g., through the work of government agencies and nonprofit organizations). As stated by James Boyd, "What may appear to be striking differences in the cost of alternative policies are primarily differences in who bears the cost of conservation" (Boyd et al. 1999, p. 6). In this section, four categories of buffer management costs are described, followed by case studies of empirical cost analyses.[1]

i. Opportunity costs

In most cases, the largest cost of a buffer program or policy is the opportunity cost associated with the productive activities (i.e., farming, grazing, forestry, commercial or residential development) that are given up by the landowner in order to establish or maintain natural vegetation in the buffer area. In some policy settings, all human activities are restricted in the buffer. In others, the intensity of the use is decreased, often resulting in lower production, and the opportunity cost reflects the value of this reduced productivity. In situations of mandatory buffer rules, the landowner incurs the cost of conservation. In situations of voluntary buffer programs, landowners will likely need to be compensated for their losses (Randhir et al. 2011).

ii. Acquisition costs

Conservation of biodiversity and other ecosystem services often entails the protection of the land in a natural state. This can be accomplished through the outright purchase of land or through the purchase of the property's "use" rights (e.g., development rights, grazing rights, or timber harvesting rights). Acquisition costs should reflect the opportunity costs of the foregone activities. Costs of acquiring just use rights are often less than the costs of buying the land outright, particularly in the case of purchasing development rights because often some other non-harmful (e.g., recreational) uses can continue.

[1] Naidoo et al. (2006) and Coggan et al. (2010) provide more comprehensive discussions of conservation costs.

iii. Transaction costs

Many conservation programs involve an exchange between two or more parties--for example, between a government agency and one or more landowners. The exchange could be in the form of a transfer of property rights to eliminate a harmful land use, or it could be an incentive payment for a change in land-use behavior to a less-intensive use. In addition to the actual payment (i.e., acquisition cost or incentive payment), other costs associated with engaging in the exchange, known broadly as transactions costs, may occur (McCann 2013). *Information costs* are the costs associated with identifying potential conservation targets (e.g., land parcels), estimating the benefits of conservation, educating landowners and the public, understanding the conservation values of individual landowners, and other knowledge costs associated with reducing uncertainty in the exchange. Information costs can also arise when accounting for the complexity of future climate change (Mills et al. 2014). Landowners can also experience information costs—for example, the time spent learning about how the program works and determining if it is beneficial (McCann and Claassen 2016). These costs can be a barrier to landowner participation in voluntary programs. *Contracting costs* include the time and legal costs associated with negotiating a contract. These costs can be quite high if each contract needs to be context-specific. *Coordination costs* are the extra costs associated with identifying the best spatial targets or coordinating the conservation efforts of multiple landowners—for example, targeting multiple landowners in a particular watershed because of critical water quality issues. Often agencies will provide an extra incentive (i.e., a bonus payment) for spatially coordinated parcels or buffers (Parkhurst et al. 2002). Key factors that influence transaction costs include: (1) the characteristics of the transaction, including the complexity of the property right, frequency of transactions, and the level of institutional or ecological uncertainty; (2) the characteristics of the parties involved, including previous experience, level of trust in the other party, and social connectedness among participants; and (3) the institutional context including the full set of legal, social, and political rules (Coggan et al. 2013).

iv. Management costs

Once a buffer conservation policy or program has been selected and participants identified, there are additional costs associated with ongoing management. *Installation, restoration, and maintenance costs* cover planting of native vegetation, removal and control of invasive species, and other onsite activities. *Administrative costs* include staffing, office space, and meeting costs for ongoing operations of the government agency or nonprofit conservation organizations (e.g., land trusts). Even “free” technical assistance and public education activities incur some level of administrative costs, although they are rarely assessed. *Monitoring costs* cover site visits and reporting associated with ensuring conservation goals are being met. *Enforcement costs* are legal and other costs associated with litigation and collecting fines.

v. Case study: Willamette Basin, Oregon

Oregon's Department of Environmental Quality estimates the total cost of restoring 96,000 acres of riparian buffers and improving stream habitat throughout the Willamette Basin, where two-thirds of Oregon's population lives, to be between $593 million and $1.2 billion (average $900 million) for an initial 15-year period and annual land rental payments of $13 million thereafter to meet water quality goals of reduced sediment runoff, decreased stream temperatures, and improved aquatic habitat (Michie 2010). 75 percent of this cost would go to restoration on agricultural lands, 15 percent to restoration on lands within urban growth boundaries, and the remainder to forested lands. The analysis assumes that most restoration projects will occur at sites with little or no vegetated cover, identified as having less than 12 percent canopy cover but not impervious surface, and will utilize best management practices (BMPs). Costs would cover 60-meter buffers on larger streams and 30-meter buffers on smaller streams. Installation costs can vary widely and include site preparation, plants and other materials, labor, and ongoing maintenance. Estimated costs, including both buffer installation costs and land rental payments, average $4,695 per acre for rural areas and $10,543 per acre for urban areas. Additional upfront costs include $6,307 per acre for fencing around buffers in grazing areas (about 8 percent of buffers in the study area) and $12,333 per acre for bank stabilization and other instream habitat improvement activities (61 percent of urban buffers, 33 percent of agricultural buffers, and 10 percent of forest buffers). Ongoing rental payments are estimated to be $128 per acre per year for rural lands and $240 per acre per year for urban lands. All costs are in 2008 dollars. Table 3 shows upper and lower bounds for BMP costs estimates.

Table 3. Estimated per-acre costs (2008 USD) associated with 15-year buffer restoration best management practices in the Willamette Basin, Oregon. (Source: Michie 2010)

BMP	Average Cost	Lower Bound	Upper Bound
Rural Planting	4,695	3,964	5,426
Urban Planting	10,543	8,962	12,124
Instream Habitat	12,333	10,483	12,183
Fencing	6,307	5,362	7,254

VI. Other case-study cost estimates

The majority of buffer cost estimates in the literature focus on agricultural or commercial forestry lands rather than urban development and may not be directly applicable to the Great Bay watershed. However, they do provide some information on the lower bound of costs or the upper bound of landowner participation in voluntary programs (Roberts et al. 2009). Table 4 summarizes information from four studies, two of which utilize survey data on landowner willingness to accept (WTA) payment to voluntarily forego production activities (Kline et al. 2000; Yu and Belcher 2011); the other two estimate the cost to landowners of mandatory buffer policies (Nakao and Sohngen 2000; Roberts et al. 2009). Interestingly, Kline et al. (2009) show WTA varies from $38 per acre to $137 per acre depending on landowner objectives, with the lowest payments required for landowners with recreational objectives and the highest payments required for landowners with production objectives.

Table 4. Comparison of estimated costs of buffer management.

Study	Location	Buffer Width	Costs Included	Annual Cost Estimate
Kline et al. 2000	Pacific Northwest	200-foot	opportunity costs of timber harvest	$128-$137 per acre for landowners with timber objectives; $54-$69 per acre for landowners with timber and non-timber objectives; $38-$57 per acre for landowners with recreation objectives
Nakao and Sohngen 2000	Maumee River Basin, Ohio	50-foot to 150-foot	opportunity costs of crop production	$61-$110 per acre
Roberts et al. 2009	Harpeth River Watershed, Tennessee	150-foot	installation, maintenance, livestock exclusion, and opportunity costs of crop and grazing production	$78-$118 per acre for cropland; $52-$351 per acre for pasture; $1.3 million regionally
Yu and Belcher 2011	Prairie Pothole Region, Saskatchewan (Canada)	ten-meter	opportunity costs of crop production	$30 per acre

III. What lessons can we learn from existing benefit-cost analyses?

Benefit-cost analyses (BCAs) are often used to guide management decisions or policy making. The most comprehensive economic analysis of buffer management will include a comparison of economic values for all benefits and all costs. If net benefits are positive (i.e., total benefits exceed total costs), then a buffer program or policy is deemed economically efficient because society as a whole can be made better off. While political feasibility and social justice issues are also concerns for buffer management, they are not the focus of this literature review but will be discussed briefly in the policy section.

Only five riparian buffer BCA case studies were identified in the literature (Table 5). In all five, benefits were evaluated for hypothetical buffer programs using survey methods rather than reporting actual benefits achieved through an existing program. While there were mixed results in terms of net benefits, the general consensus from these studies is that the total market and non-market benefits generated from riparian buffer zones outweigh their costs. Unfortunately, none of the studies included *all* benefits and *all* costs, so drawing formal conclusions is not possible. Of the five studies, the most relevant for the Great Bay watershed is the case study highlighted below.

i. Case study: Canaan-Washademoak Watershed, New Brunswick, Canada

The Canaan River and Lake Washademoak watershed in southern New Brunswick includes 91 tributaries and 12 major subwatersheds across an area of 2,160 square-kilometers. Land use is predominantly forest but also includes agriculture and residential development, with recent trends towards more commercial (service sector) and residential development for commuters and seasonal (recreational) residents. In a recent benefit-cost analysis, Trenholm et al. (2013) investigated the net social benefits of providing water filtration, fish and wildlife habitat, and forest scenery ecosystem services through the establishment and maintenance of riparian buffers in the watershed.

To estimate benefits from improved ecosystem services, a contingent valuation survey was mailed to three groups of residents: (1) households owning property in riparian areas of the watershed, (2) households owning non-riparian property within the watershed, and (3) households living outside the watershed in southern New Brunswick. Survey respondents were asked to evaluate four hypothetical buffer programs that varied over buffer size (30 meters versus 60 meters), the type of land protected (forest only versus forest, agriculture, and residential), the magnitude of the expected level of improvement in ecosystem services (slight, moderate, or large), and the level of payment (increase in annual income taxes over ten years). Estimated annual household willingness to pay (WTP) for buffer enhancement programs ranged dramatically from -$4.13 to $42.28 (2007 Canadian Dollars (CDN)) across the four buffer programs and four statistical methods (a total of 16 sensitivity analyses). Total WTP ranged from -$1.4 million to $110 million (2007 CDN). Only one of 16 analyses resulted in negative values, indicating a general positive WTP for buffer enhancement programs.

Costs for the two buffer scenarios (30-meter and 60-meter) were limited to the opportunity costs of foregone productivity. Forest opportunity costs were estimated using a net present value wood supply model that was developed and calibrated to the region. Agricultural opportunity costs were estimated using regional agricultural land rental values. Residential opportunity costs were estimated using regional assessed property values. Total opportunity costs (calculated by multiplying per-acre opportunity costs for each land-use type by its area within the buffer) ranged from $1.3 million to $5.4 million (2007 CDN) for 30-meter buffer scenarios and from $2.2 million to $10.4 million (2007 CDN) for 60-meter buffer scenarios.

A total of 32 different benefit-cost sensitivity analyses were conducted, and results were mixed. Half the 16 most conservative (i.e., low-benefit and high-cost) net present value calculations, ranging from -$17 million to $36 million (2007 CDN), resulted in negative net benefits. In contrast, all 16 of the least conservative (i.e., high-benefit and low-cost) calculations produced positive net benefits ranging from $8 million to $119 million (2007 CDN). Unfortunately, like all the others, this study did not include all benefits and all costs, so results are inconclusive. The inclusion of other costs (e.g., restoration, maintenance, monitoring, and enforcement costs) would likely decrease the number of positive net benefit calculations further, while the inclusion of other benefits (e.g., tourism from outside southern New Brunswick) would also change the overall results.

ii. Cost-effectiveness as an alternative to benefit-cost analysis

Some benefit-cost analyses use biophysical rather than economic metrics to measure benefits (Balana et al. 2012, Qiu and Dosskey 2012, Tiwari et al. 2016, Yang and Weersink 2004). These cost-effectiveness studies typically assess the economic costs associated with different ecological outcomes and either (1) identify the minimum cost of achieving a particular ecological goal, or (2) identify the best ecological outcome that can be achieved within a fixed budget. These types of analyses have been used for spatial targeting of buffer conservation and restoration efforts as well as determining variable buffer widths, although none have been conducted in urbanizing regions. A similar process could be used by New Hampshire resource managers and decision makers to assist in targeting buffer conservation efforts in the Great Bay watershed, although the modeling efforts require expertise and can be quite expensive.

Table 5. Comparison of benefit-cost analyses from existing literature.

Study	Location	Buffer Action	Benefits and Costs*	Net Benefits
Amigues et al. 2002	south-central France	preservation of 50-meter buffer along 70 kilometers of Garonne River	WTP = \$7-\$10 per person $NPV_{benefits}$ = \$7.4-\$14.0 million Costs = \$294-\$447 per hectare NPV_{costs} = \$1.6-\$2.4 million	\$5-\$12.4 million
Holmes et al. 2004	western North Carolina	restoration (planting trees and grasses) along six miles of Little Tennessee River	WTP = \$4.54 per household per mile for full six miles $NPV_{benefits}$ = \$2.84 million Costs = \$30,202 per mile NPV_{costs} = \$0.18 million	\$2.56 million for full six-mile restoration \$184K for 2 miles \$281K for 4 miles
Loomis et al. 2000	Colorado	restoration of buffer strips along 45 miles of Platte River	WTP = \$252 household† $NPV_{benefits}$ = \$19-\$70 million $NPV_{water\ leasing}$ = \$1.13 million $NPV_{easement\ costs}$ = \$12.3 million †includes leaving more water in river and restricting land uses in addition to buffers	\$5.7-\$56.7 million
Thomas and Blakemore 2007	Wales (UK)	improvement of fish habitat (fencing and restricted land use) along Wye River	WTP = £38-49 per angler $NPV_{benefits}$ = £318K – 1.5 million $NPV_{cost\ 2.7\ km\ fence}$ = £17,200 $NPV_{cost\ 20\ km\ fence}$ = £127,400 $NPV_{cost\ full\ program}$ = £1.1 million	-£782K-£400K depending on timing of benefits and improvement program
Trenholm et al. 2013	New Brunswick (Canada)	four buffer programs in Canaan-Washademoak watershed	WTP = -4.13-42.28 CDN $NPV_{benefits}$ = -1.4-110 million NPV_{costs} = 1.3-10.4 million	-17-119 million (2007 CDN) depending on buffer scenario

*All willingness to pay (WTP) values are per year. NPV stands for Net Present Value—essentially, all costs and benefits have been converted from future values to current (present) values.

C. What are the economic aspects of buffer-related policy options?

Protection, restoration, and ongoing management of buffers in the Great Bay watershed has the potential to protect and improve water quality, wildlife habitat, and other ecosystem services. However, buffers, like many other small natural features with ecological roles extending beyond their area, face particular management challenges but also present unique opportunities (Gonzalez et al. 2017, Hunter et al. 2017). Their relatively small size and lack of detailed information about their benefits can lead to perceptions of insignificance by landowners, policymakers, and the public. In addition, a spatial mismatch often exists between those who reap the benefits of conservation and those who incur the costs. However, conservation does not typically require foregoing productive land uses across the entire land parcel, so some production remains viable.

A variety of buffer management approaches have potential, but it is important to assess not only the total benefits and costs, but also their distribution. In situations where society has decided that public rights to environmental quality and ecosystem service provision overrule the private property rights of individual landowners, the cost burden of managing buffers falls on the landowner, while non-excludable benefits spill over parcel boundaries to nearby residents and the public at large. In situations where the private property rights of individual landowners are favored over society's rights to ecosystem service provisioning, the cost burden of managing buffers falls on those who receive value from the ecosystem services and are often borne by government agencies or nonprofits. The discussion of buffer management policies begins with the three most common approaches (buffer regulations, fee-simple purchase, and conservation easements) and continues through to less common approaches that may have future potential. The goal of any policy or group of policies is to balance public and private needs. A combination of policies may make sense in some communities or watersheds of the Great Bay ecosystem.

I. Land-use regulations

Land-use regulations such as vegetated buffer strips limit the type and intensity of activities allowed within a set distance from a water body's edge and are typically established across a relatively large region (e.g., community, watershed, or entire state). There are a number of advantages to untargeted land-use regulations. All affected landowners are treated the same, so there is no need to negotiate specific contracts. Changes to existing regulations can occur without consulting landowners. Furthermore, the regulator does not need to know the exact value of the ecosystem services provided or landowner opportunity costs to devise policy, and no coordination of activities among landowners is required. Essentially, there are minimal transaction and management costs. However, because buffers and their ecosystem service benefits are not evenly distributed across the landscape, a typical landscape-wide regulation might not target a specific environmental problem very well, and extremely large opportunity costs could make the policy politically infeasible. Treating all buffers the same may be perceived as equitable among affected landowners but could be highly inefficient if the provisioning of ecosystem services or the opportunity costs are variable across space. In addition, buffers might not actually be equitable. Consider the impact on three waterfront landowners: one owns a one-acre rectangular parcel with 150 feet of waterfront, one owns a one-acre rectangular parcel with 250 feet of waterfront, and one owns a half-acre parcel with 150 feet of waterfront. A 50-foot buffer regulation would result in a restriction on 17, 29, and 33 percent of the total parcel, respectively. Hardly an equitable outcome. In summary, untargeted land-use regulations, while administratively straightforward, could create large costs for little benefit. Although there are several ways to target land-use regulations while reducing overall opportunity costs, increases in regulatory flexibility to address ecological heterogeneity often creates higher administrative costs. That is, a tradeoff exists between the opportunity costs to landowners and the transaction and management costs to the regulator, and it may be unclear which approach minimizes the total cost burden to society.

II. Fee simple purchase

The extreme and arguably most common approach to conservation for which beneficiaries incur all costs involves the outright purchase of land by a town, state, government agency, or nonprofit organization (e.g., a land trust), that often permanently protects the land in a natural state. From an ecological perspective, this approach can be highly successful. However, this approach can also be extremely expensive and is likely inefficient for the management of buffers that may be able to coexist on parcels with productive land uses. In addition, finding enough waterfront landowners willing to sell their entire parcel is highly unlikely in urbanizing regions like the Great Bay watershed.

III. Conservation easements

Conservation easements are voluntary agreements that transfer control of one or more (but not all) rights to a government agency or land trust, typically in perpetuity. The landowner retains ownership and may continue to use the land in other less harmful ways depending on which use rights remain intact. Contracts may include a description of the property and its current ecological condition, limits on current and future use, land management requirements, conservation agency or land trust access rights, public access rights, demonstration of unencumbered ownership, remedies for breach of contract, limitations on liability of the conservation agent, statement of transferability of restrictions to future owners, and transaction details (Boyd et al. 1999). There are two broad categories of easements: purchased and donated. With purchased easements, payments are typically made to landowners for the purchase of development rights, but may also target water, mining, or grazing rights. Purchased easements can also be targeted to specific properties (e.g., those with buffers) that provide a large amount of good quality ecosystem services. Payments typically reflect opportunity costs, which are calculated as the difference between private “highest and best” land-use values with and without restrictions on that use. Donated easements are essentially charitable land donations. Several potential tax benefits exist as financial incentives for the donation of conservation easements (Sundberg 2013). The Internal Revenue Service allows federal income tax deduction of charitable contributions of land. The specific rules change periodically, depending on the political climate, but the donated conservation easements must provide a public benefit and be in perpetuity. The federal government also allows federal estate tax and gift tax deductions for the portion of a property with an easement. Several states also allow income tax deductions for donated easements. While New Hampshire does not have a state income tax and thus cannot offer an income tax deduction as an economic incentive to increase buffer conservation, it is worth noting the mixed results among those states that do offer state deductions. Sundberg (2011) found that the development of a state tax credit for conservation easements does not guarantee that a significant number of easements will actually be donated. States that offer more credits (i.e., a higher total cap or no cap at all) are more likely to have a higher level of donated easements, but these programs are also more likely to have built-in assurances or controls such as listing the specific conservation values coming from each parcel, narrowing the scope of conservation values that qualify an easement for participation in the program, and certifying that the conservation values actually exist.

The use of easements as a conservation tool in the United States has grown dramatically over the past 20 years, both in terms of quantity of lands conserved and as a percentage of total conservation, with much variation across states (Fishburn et al. 2009a, 2009b). A recent group of studies examining conservation easements held by The Nature Conservancy, the largest private land conservation organization, revealed that overall easements are achieving stated goals of identifying biological targets and selected lands adjacent to other protected areas (Kiesecker et al. 2007, Rissman et al. 2007). However, while monitoring of the land to meet legal contract requirements takes place (e.g., making sure land has not been developed), biological monitoring is not occurring (Kiesecker et al. 2007) and 56 percent of the sampled easements allowed some additional buildings (Rissman et al. 2007).

Conservation easements are less costly than outright purchase but may still be expensive depending on the use rights that are given up and the potential for landowners to behave strategically (Lennox and Armsworth 2013). Donated easements do not incur any acquisition costs but may be of lesser quality. Easements are particularly effective in situations where lots of alternative land parcels are available for development (i.e., the supply of undeveloped parcels is large) and when landowner values for conservation are relatively homogeneous throughout the area; in contrast, fee simple purchase may be a better strategy when land supply is tightly constrained (Armsworth and Sanchirico 2008). Land trusts tend to be more interested in holding easements rather than purchasing land outright (i.e., full ownership) when transaction and management costs are low and gains from landowner specialization (e.g., if some productive activities such as farming, forestry, or grazing remain unrestricted) are high (Parker 2004).

Local communities and land trusts can create programs that generate funds to purchase easements. There is evidence from two studies in Ohio that public willingness to pay to support conservation easements in riparian corridors is positive and ranges from $16.80 to $29.16 per household per year in the Grand River Watershed (Blaine and Smith 2006) and from $32.28 to $36.48 per household per year in Cuyahoga County (Blaine and Lichtkoppler 2004). However, it is also important to understand the factors that influence landowners' willingness to sell an easement. A recent survey of forest landowners in southern Vermont and western Massachusetts suggests that more than half of the respondents would not participate in any type of conservation easement program despite being offered full payment for the foregone opportunity costs of their land (LeVert et al. 2009). A payment at the high end of the land value range would likely attract 47 percent of all landowners in the sample, with differences among the subgroups from the two states (51 percent of the Massachusetts sample versus 33 percent of the Vermont sample) likely due to alternative use opportunities being greater in southern Vermont where skiing and other recreational opportunities are present. Interestingly, 63 percent of the respondents from Massachusetts and 75 percent of the respondents from Vermont had never considered granting a conservation easement prior to receiving the survey, suggesting that targeted landowner education may increase the amount of conservation easements in the future. Brenner et al. (2013) identified several key factors that predict landowner willingness to grant conservation easements, including participation in environmental organizations, recreational land-use activities, wild food gathering, and size of land holdings, all of which were more important than economic returns to productive land uses.

Local communities may have concerns regarding the impact of conservation easements on property tax revenues and associated tax rates (King and Anderson 2004). If a large number of acres are removed from the tax rolls, one of two things will happen in the short run. If tax rates remain the same, then less tax revenues are generated and the community will need to cut services. If the community maintains the level of services, then tax rates need to rise. In the long run, however, the additional conservation land could make existing residential land and remaining undeveloped land more valuable, with a corresponding higher assessed value and thus more tax revenues generated. For example, Chamblee et al. (2011) found a 46 percent price premium on land adjacent to conservation land in Buncombe County, North Carolina, with additional positive price effects for nearby properties that declined as distance from the conserved property increased. In contrast, Anderson and Weinhold (2008) found a negative price effect (47 percent reduction) on vacant land parcels with strict no-development easements and no price effect on parcels that already contained a single residence in three southern Wisconsin counties. The net effect is an empirical question recently tested by King and Anderson (2004) using a case study of Vermont, which showed that conservation easements over the period 1990-1999 led to a short-term increase in the property tax rate (needed to maintain services as required by Vermont state law), but that this increase only lasted for two years and then tax rates fell such that the long-run effect on property tax rates was neutral or negative.

IV. Impact fees

Impact fees are payments from landowners to a government agency for permitted development or other intensive land use that causes ecological damage. For example, an impact fee could be charged for removing or degrading vegetation within a riparian buffer of a designated width. The regulator could set a simple one-size-fits-all fee, thereby lowering transaction and management costs; however, this could result in fees that severely under- or overvalue benefits and lead to increased litigation. Instead, the regulator could attempt to set the fee equal to the value of the ecosystem services lost via the development of land management activity. Such a system would ensure that landowners pay for their exact damage; however, the cost of determining which ecosystem services will be damaged by an activity and the controversy and uncertainty of measuring the level of damage in monetary terms are likely to be quite high (Ruckelshaus et al. 2015).

V. Payments for ecosystem services

Targeted payments for ecosystem services (PES) can be made to landowners as incentives to: (1) engage in some activity or group of activities (e.g., installing vegetated buffers) that maintain, restore, or improve the provision of one or more ecosystem services; (2) reduce the intensity of active land uses (e.g., building fewer homes); or (3) cease productive land use altogether. Payments can be monetary or in-kind and can come from government agencies, nonprofit organizations, or the direct beneficiaries (Engel et al. 2008, Engel 2016). Payments can also come in the form of tax credits or deductions. For example, several states (including all six New England states) have programs that offer property tax reductions for current use assessed values, with a great deal of variation in the method used to determine the actual reduction, the criteria for participation, and the penalty for altering the land use to a more intensive (e.g., developed) use (Sundberg 2014). New Hampshire's Current Use Taxation Program allows property taxation at lower "traditional use" values rather than the real estate market value (typically developed land use) for ten or more acres of agriculture, forestry, or wildlands. A similar tax credit program for buffer areas might provide good incentives to waterfront landowners in the Great Bay watershed.

PES schemes do have some drawbacks, however. The transaction and management costs can be quite high, and it can be extremely difficult to select the best participants from a group of applicants (Sorice et al. 2011). For example, landowners are more knowledgeable of opportunity costs than regulators and, therefore, can extract payments that are much higher than their minimum willingness to accept (Lennox and Armsworth 2013). In addition, the offering of payments may weaken the landowner's sense of a moral obligation, resulting in less conservation than is possible because recipients might have accepted smaller payments leaving funds for extra conservation elsewhere. Further, to maximize gains in social welfare, PES schemes have to set payments equal to the value of benefits procured, but determining their values can be challenging.

VI. Assessment of buffer-related policy options

The efficacy of alternative buffer management policies is case-dependent and influenced by the specific ecosystem services of interest, the level of connectivity required to provide the targeted services, and the magnitude and distribution of benefits and costs. Buffers, in general, provide a wide variety of ecosystem services; however, an individual buffer in a specific location may be most valued for its provision of one kind of service. Identification of the specific ecosystem service of interest is important because it determines the spatial extent of the landscape that managers or regulators need to worry about, the uses of that landscape that are impairing the ability of the buffer to provide its services, and how many landowners need to be involved in the conservation effort. If the number of landowners needed for conservation success is low and buffers providing high-quality ecosystem services can be targeted, then incentive-based approaches (e.g., land purchases, easements, and payments for ecosystem services) are simpler. If many landowners need to be involved, then simple and non targeted approaches (e.g., buffer regulations and public education) may work better.

The magnitude and distribution of costs also affect the efficacy of buffer policies. Relevant costs include opportunity costs, transaction (information, contracting, coordination) costs, management (administrative, monitoring, enforcement) costs, and, in some cases, acquisition costs. Large-scale land purchases are not likely to be cost-effective for managing buffers due to the high costs associated with purchasing land outright. In comparison, economic incentives that reduce land-use intensity rather than eliminating all land uses cost less and are much more likely to fall within organizations' conservation budgets. Community attitudes towards conservation can influence the dominant property rights regime that ultimately determines who incurs what cost. Sharing the cost burden among landowners and the rest of society may result in higher total costs but may provide more equitable (and perhaps more politically feasible) alternatives.

D. Summary and Conclusions

This review synthesized existing literature on the economic benefits and costs of buffer management and policies in order to provide information that facilitates the best possible decision making today and to identify critical gaps in our current knowledge that would allow for better decision making in the future.

This review found that studies investigating the effect of vegetated buffers on housing prices produced mixed results, likely due to two opposing effects of buffers on property values. Improved ecosystem service provisioning may increase prices for adjacent and nearby properties. In contrast, lost development potential and degraded scenic views may reduce prices. In comparison, the general consensus of relevant literature is that higher property values are associated with better water quality. In addition, these positive effects, which can be as high as a 30 percent increase in property value, extend far beyond waterfront properties. In addition, while this literature review is mainly focused on economic values of households living within close proximity of the focal resource, it is worth noting that additional benefits of buffer-related ecosystem services accrue to visiting recreationists and other tourists.

To address distributional issues between those who incur the costs of buffer management and those who reap the benefits, societies can establish policies, programs, or institutions that align the interests of private landowners with social interests. In some cases, this involves governments regulating landowner behavior (e.g., establishing buffer rules), forcing landowners to bear management and opportunity costs. In other cases, government agencies or nonprofits offer incentives to landowners to facilitate provisioning of the socially efficient amount of buffer-provided ecosystem services.

Untargeted buffer regulations, while administratively straightforward, could generate large costs for landowners. Although there are several ways to target land-use regulations and reduce overall opportunity costs, increases in regulatory flexibility to address ecological heterogeneity often create higher administrative costs. That is, a tradeoff exists between the opportunity costs to landowners and the transaction and management costs to the regulator, and it may be unclear which approach minimizes the total cost burden to society.

In comparison, targeted payments for ecosystem services can be made to landowners as incentives to: engage in some activity or group of activities (e.g., installing vegetated buffers) that maintain, restore, or improve the provision of one or more ecosystem services; reduce the intensity of active land uses (e.g., building fewer homes); or cease destructive land use altogether. Payments can be monetary or in-kind and can come from government agencies, nonprofit organizations (e.g., land trusts), or the direct beneficiaries. Purchased conservation easements are one way of targeting critical buffers. Payments can also come in the form of tax credits or deductions. For example, several states have programs that allow property taxation at lower “traditional use” values rather than the real estate market value. A similar tax credit program for buffer areas might provide good incentives to waterfront landowners in the Great Bay watershed.

The efficacy of alternative buffer management policies is case-dependent and influenced by the specific ecosystem services of interest, the level of connectivity required to provide the targeted services, and the magnitude and distribution of benefits and costs. If the number of landowners needed for conservation success is low and buffers providing high-quality ecosystem services can be easily targeted, then incentive-based approaches (e.g., easements and payments for ecosystem services) may work better. If many landowners need to be involved, then simple and untargeted approaches (e.g., buffer regulations and public education) may be more appropriate. Economic incentives that reduce land-use intensity rather than eliminating all land uses cost less and are much more likely to fall within organizations' conservation budgets. Community attitudes towards conservation can influence the dominant property rights regime that ultimately determines who incurs what cost. Sharing the cost burden among landowners and the rest of society may result in higher total costs but may provide more equitable (and perhaps more politically feasible) alternatives.

Several gaps in our current understanding of the economics of buffer management were uncovered. First, while there is substantial literature covering the effects of water quality on property values, there are very few empirical analysis of the effects of the physical buffer itself. Anecdotal evidence provided mixed results, suggesting that some waterfront landowners enjoy the privacy of a densely vegetated buffer while others prefer an unobstructed view of the water body. Second, only two case studies of New Hampshire residents could be found and both of these were conducted using lakefront property sales data from the early 1990s. As a result, the Great Bay Estuary Project is forced to extrapolate willingness to pay values from other diverse locations. Third, no studies comparing a full set of benefits and costs associated with buffer management could be located, and existing benefit-cost analyses were highly inconclusive. Finally, no studies that compared the economic and ecological outcomes of buffer regulations to outcomes of other buffer policies were found. This has ramifications for the efficiency of long-term buffer planning and management.

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Buffer Options for the Bay: Exploring the Trends, Science, and Options of Buffer Management in the Great Bay Watershed

Social Science Bibliography

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Potential categories/avenues:

A. Stakeholders' preferences, perceptions, understanding, awareness, values re: buffers
B. Stakeholders' perspectives/opinions about policy options (e.g., Wells study)
C. Socioeconomic benefits of buffers for individuals/communities (e.g., quality of life, well-being, health, recreation, aesthetics, property values, etc.)
    a. *Maybe David/Dana have covered this sufficiently; if not, want to make sure it's complete*
D. Cost-benefit analysis/ecosystem service valuation studies of buffers
    a. *Think Dana will be covering this*

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Buffer Options for the Bay: Exploring the Trends, Science, and Options of Buffer Management in the Great Bay Watershed

Takings: Executive Summary/FAQ

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What is a taking?

A municipality's authority to regulate land use is a balance between private property rights and the purpose of government to promote the public health, welfare, and safety. To benefit from the ecosystem services and values buffers provide, towns may wish to enact regulations and ordinances to protect them. However, this may result in a ***taking***, or the total or near total governmental deprivation of private property requiring payment of "just compensation" to the owner, and raise the potential for regulatory "takings" lawsuits. Both the U.S. Constitution and the New Hampshire Constitution secure property rights, and guard against "taking" private property:

> **Fifth Amendment of the United States Constitution:** *"No person shall […] be deprived of life, liberty, or property, without due process of law; nor shall private property be taken for public use, without just compensation."*
>
> **Article 12 of the New Hampshire Constitution:** *"Every member of the community has a right to be protected by it, in the enjoyment of his life, liberty, and property; […] but no part of a man's property shall be taken from him, or applied to public uses, without his own consent, or that of the representative body of the people[.]"* (N.H. statute RSA 498-A Eminent Domain Procedure Act supplies the "just compensation" requirement.)

In N.H., RSA 674:16 (Grant of Power) enables a municipality's authority to zone and the power to adopt a zoning ordinance. The circumstance in which an ordinance or regulation constitutes a taking depends on several factors, and there is no case history in N.H. that establishes a "bright line" beyond which a regulation becomes a taking. In N.H., a governmental regulation can be a taking, even if the land is not physically taken, if it is an arbitrary or unreasonable restriction that substantially deprives the owner of the economically viable use of his or her property to benefit the public.

How can I tell if an ordinance or regulation is a taking?

The first step is to determine whether the regulation affects a protected property right. The N.H. Supreme Court defines **property** as *"refer[ring] to a person's right to 'possess, use, enjoy and dispose of a thing and is not limited to the thing itself."*

If the regulation *does* affect a property right, a municipality can be subject to takings claims either when a regulation restricts "***all*** economically beneficial or productive use of land" (a complete or ***per* se taking**) or when the regulation goes "too far" and infringes on private property rights (a **partial taking**). A per se taking would mean that the regulation takes away all economic or productive use of the land on the entire parcel.

How can I tell if an ordinance will be considered a partial taking?

Takings claims are evaluated case by case and are based on: (1) the economic impact on the property owner; (2) the degree of interference with the owner's reasonable investment-backed expectation; and (3) the character of the occupation.

(1) Economic impact on the property owner: N.H. courts use a "before and after" comparison to measure the degree to which a government regulation diminishes a property's economically viable use. This test attempts to determine fair market value immediately before and immediately after the regulation. For most properties, N.H. courts use a comparable sales approach to assess fair market value.

(2) Owner's reasonable investment-backed expectations: N.H. courts look at the reduction of value of regulated income and investment properties, based on the purpose for which the property had been purchased. If the landowner has an initial expectation to use the property for a purpose that is now prohibited by the regulation, courts will inquire into whether the expectation is objectively reasonable. Individuals who claim property rights in a "heavily regulated field" typically have a difficult time establishing they have an objectively reasonable expectation the state will not enact new regulations that will affect their property. For example, N.H. legislation has identified the Lamprey River as a "Protected River;" this could influence the court's decisions on whether there was a reasonable investment-backed expectation regarding certain types of development in the Lamprey River watershed. N.H. courts will also look to the regulatory scheme currently in place in that community to determine whether government action could have been reasonably anticipated.

(3) Character of the government action: Lastly, N.H. courts evaluate the character of the government action by weighing the public interest served by the regulation against the private burden on an affected landowner. This definition of character is a determination of whether a government action constitutes a taking based on whether the burden on a private property interest should be carried by the landowner or the public at large. In the context of buffers, it is important to note that flood protection and water quality are important public benefits.

What steps can communities take to avoid a takings suit when trying to protect buffers?

The risk of municipal takings liability is low, so long as municipalities follow sound planning principles. The federal government *encourages* communities to enact certain types of regulations designed to reduce floodplain hazards (a key benefit of buffers), as does the legislatively approved Coastal Risks and Hazards Commission Report.

1. Make sure you have the enabling authority to create the ordinance or regulation; municipalities should clearly identify the enabling statute that allows the enactment of the ordinance or regulation.
2. Enact regulations in a way that preserves some economically viable use of the land.
3. Indicate that one of the purposes of the regulation is to promote hazard mitigation.
4. Tie the buffer regulation to goals in an approved master plan. Include goals in the management plan that address the need for buffers for flood protection, water quality protection, etc. Indicate that the purpose of these goals is to protect the health, safety and welfare of citizens in the community.
5. Acknowledge uncertainty in your master plan. By addressing uncertainty of flood hazards or changing environmental conditions, municipalities can acknowledge the unpredictability of future conditions, while at the same time emphasizing the importance of taking action despite uncertainty.

And remember…

In New Hampshire, scientific data is very rarely needed to justify the enactment of ordinances. All that is needed is a reasonable justification.

A municipality might consider using the principle of No Adverse Impact (NAI) as a standard when creating floodplain regulations to avoid takings claims. NAI is the principle that the action of one property owner may not adversely impact the flooding risk for other property owners.

A taking claim must be "ripe" for judicial review before the court will determine whether a regulation constitutes a compensable taking. The claimant must at least have applied for and been denied a variance or special use permit before a court will hear the case.

If you have a valid and justifiable ordinance in place, but the board misinterprets the ordinance in a way that affects a property right, that is not a taking. The taking stems from the validity of the ordinance itself.

For more information on the legal rights of communities…

This summary borrows heavily from the Vermont Law School Land Use Clinic study of June 2012, funded by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration through the National Sea Grant Law Center Grants Program at the University of Mississippi to look at legal authority and consequences of basing municipal policy decisions in New Hampshire on best available scientific models. The full document can be found here: https://goo.gl/q3Cp4X.

For more information on this topic, see an extended analysis conducted by the BOB team at: www.nhbufferoptionsforthebay

Buffer Options for the Bay: **New Hampshire Takings Law** and the **Natural Law** basis of **Property Rights** & **Government Regulation**

Christos Tsiamis
great bay national estuarine research reserve, 2018

The legal resources component of the *Buffer Options for the Bay* project, funded in part by the National Oceanic and Atmospheric Administration (NOAA) through the University of Michigan National Estuarine Research Reserve Science Collaborative, was led by Christos Tsiamis (GBNERR), with support from Cory Riley (GBNERR), Steve Miller (GBNERR), and Lisa Graichen (UNH Cooperative Extension and N.H. Sea Grant), Project Team members (in particular, Cory Riley, Jill Farrell, and Dolores Leonard) and Advisory Committee members (in particular, John Coon and Julia Peterson, who provided input during planning, review, and revision). The opinions herein are not legal advice. This document follows from the Vermont Law School Land Use Clinic study of June 2012 (at https://goo.gl/q3Cp4X), funded by NOAA to look at legal authority and consequences of basing municipal policy decisions in N.H. on best available scientific models.

SUMMARY: While individual property rights and municipalities' authority to enact buffer regulations may seem like countervailing forces at opposite ends of a political spectrum in New Hampshire, they both arise from express grants under civil law, they both originate from the natural law of reason, and they both represent the struggle between self-love and public good that yields what America's Founders' called our "liberty." In general, then, the risk of municipal taking liability is low in New Hampshire, *provided that* the regulation advances a legitimate state interest (like flood risk attenuation) and municipalities follow sound planning principles (see Recommendations in section IV, Conclusion, below).

I. INTRODUCTION

To benefit from the ecosystem services and values buffers provide, towns may wish to enact regulations and ordinances to protect them. The resulting restriction of property rights, however, raises the potential for regulatory takings lawsuits.

A ***taking*** is the total or near total governmental deprivation of private property requiring payment of "just compensation" to the owner.

This fact sheet focuses on the most common concerns regulatory takings related concerns **(Appendix 1)** we heard from watershed professionals and residents in New Hampshire, almost all of which were from a property rights perspective, and more than half of those simply concerned the "taking" definition itself, to which this synthesis and annotated list of legal resources on N.H. takings law **(Appendix 2)** attend.

II. HISTORICAL BACKGROUND

The evolution of takings law sums as the quest to find that "reasonable" balance between the **"natural right" (Box 1)** of property ownership, upon which individual liberty depends, and the purpose and authority of our consent-based state and federal governments **(Boxes 3 and 4, respectively)** (*for* "natural rights" *see, e.g., Cicero, 44 BC; Locke, 1689; Sidney, 1698; Gordon, 1720; Madison, 1787; Adams, 1851; Boyd, 1903; Farber et al., 1993; McConnell, 1998; BarBri, 2005; LOC, 2017; and for* "consent-based government" *see, e.g., Plato, ca. 380 BC; Montesquieu, 1749; Blackstone, 1769; Hobbes, 1651; Spinoza, 1670; Mill, 1859; Salzman and Thompson, 2014*). The formula for that evolution might look like this:

Natural law →
Natural rights →
Society →
Liberty →
Consent to government →
Government authority →
Constitutional civil laws →
Civil property rights **+**
Governmental regulatory powers →
Taking lawsuit →
*Court: Protected property right**?*** →
*Court: Compensable taking**?***

Box 1. The natural law basis of natural right of self-preservation

Declaration of Independence (1776), in part:

"When… it becomes necessary for one people to… assume… the separate and equal station to which the **Laws of Nature and of Nature's God** entitle them,… they should declare the causes which impel them to the separation.

"We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain **unalienable Rights**, that among these are Life, Liberty and the pursuit of Happiness…."

[The first] ***Constitution of New Hampshire (1776), in part:***

"WE… [h]ave taken into our serious consideration the… many grievous and oppressive acts of the British Parliament, depriving us of our **natural**… **rights** and… destroying the lives and properties of the colonists…."

N.H. Constitution, Article 2 (1784), in part:

"All men have certain **natural**, essential, and inherent **rights** - among which are, the enjoying and defending life and liberty; acquiring, possessing, and protecting, property; and, in a word, of seeking and obtaining happiness...."

Natural rights

Our unalienable, natural right to survive—expressed variously as the rights of life, liberty, property, and pursuit of happiness in the New Hampshire Constitution and the Declaration of Independence **(Box 1)**—derives from nature and the natural law, which is that all organisms behave in ways that they perceive will benefit them (Locke, 1689; Lasswell, 1977).

Purpose and formation of society

Yet, when people enter **society (Box 2)**, they must consent to suspend the full enjoyment of some of their natural rights to ensure one another's security. In other words, they swap pure individual *freedom* for the security—the individual *liberty*—that community affords, because reason tells us that individual liberty increases when community security also increases. The Founders and their influences deemed this positive feedback loop between "self-love" and social-love natural, logical, and most of all useful (Lucretius, ca 55 BC; Hobbes, 1651, Locke, Gordon, 1721; Hume, 1738; Franklin, 1745; Madison, 1787; Jefferson, 1814; Mill, 1859; Mill, 1863; Hayek, 1960; Stewart, 2014). The same logic applies to the natural synergy between

Box 2. Constitutional declaration of the purpose of society

N.H. Constitution, Article 3 (1784):

"When men enter into a state of society, they surrender up some of their natural rights to that society, in order to ensure the protection of others; and, without such an equivalent, the surrender is void."

Box 3. Constitutional declarations of the purpose of government

N.H. Constitution, Article 1 (1784), in part:

"…all government of right… is… instituted for the general good."

N.H. Constitution, Article 10 (1784), in part:

"Government being instituted for the common benefit, protection, and security, of the whole community, and not for the private interest or emolument of any one… or class.…"

U.S. Constitution, Preamble:

"We the People of the United States, in Order to form a more perfect Union, establish Justice, insure domestic Tranquility, provide for the common defence, promote the general Welfare, and secure the Blessings of Liberty to ourselves and our Posterity, do ordain and establish this Constitution for the United States of America."

Box 4. Constitutional authority of our consent-based government

N.H. Constitution, Article 1 (1784):

"All men are born equally free and independent; therefore, all government of right originates from the people, is founded in consent, and instituted for the general good."

Declaration of Independence (1776), part:

"…That to secure these rights, Governments are instituted among Men, deriving their just powers from the consent of the governed[…]."

individual property rights and a community's interest in a healthy environment. For instance, landowners and their communities benefit from buffers that enhance water quality, slow erosion, and soak up floodwaters.

Purpose of government

Thusly into the security and collective harmony of liberty that society affords, people consented to government **(Box 3)** designed to ensure the common good and security of the whole of society.

Government formed by consent

We, the People, either expressly or tacitly, still **consent (Box 4)** to that form of government today. Thus, all legitimate government authority in America derives from and is limited to the people's consent, *including* the government's regulatory authority under the **police power (Box 6).**

III. CONSTITUTIONAL BACKGROUND

A. Federal takings law

The civil laws and court decisions rendered in colonial America and the early United Stats of America make evident the importance of property rights (LOC, 2017). Indeed, our **takings protections (Box 5)** emanate from the highest civil (as opposed to natural) laws in the nation and state: the U.S. and N.H. Constitutions.

The U.S. Constitution and N.H. Constitution and laws further limit the police power by requiring public use (interpreted as public *purpose*) of taken property and payment of just compensation to property owners under certain circumstances (U.S. Const., amends. V and XIV; N.H. Const., Art. 12; N.H. RSA 498-A; *Heiss Case (1892); Boom Co. v. Patterson (1879)*; *United States v. Carmack (1946)*;

Box 5. taking clauses in U.S. & N.H. Constitutions

Fifth Amendment of the United States Constitution:

*"No person shall [...] be deprived of life, liberty, or **property**, without due process of law; nor shall private **property** be taken for **public use**, without **just compensation**."*

Article 12 of the New Hampshire Constitution:

*"Every member of the community has a **right** to be protected by it, in the enjoyment of his **life**, **liberty**, and **property**; [...b]ut no part of a man's **property** shall be taken from him, or applied to **public uses**, without his own **consent**, or that of the representative body of the people[.]"* (N.H. statute RSA 498-A Eminent Domain Procedure Act supplies the ***just compensation*** requirement.)

Ruckelshaus v. Montsanto Co., 467 U.S. 986, 1014 (1984); VLS, 2012:82; Cornell, 2017a; and Cornell, 2017d).

While the Supremacy Clause of Article VI of the U.S. Constitution establishes the precedence of the federal Constitution and federal laws over state laws and constitutions (Cornell, 2017c; Salzman, 2014), the 10th Amendment establishes that the States retain all rights not delegated to the federal government or prohibited to them by the Constitution. Among those rights is the States' undoubted **police power (Box 6)** to promote the ***"public health, safety, and welfare"*** (*Wisconsin* at 220), which includes the power to regulate the *"bundle of rights"* that comprise the right of property ownership (Lucas at 1027; LOC, 2017; Cornell, 2017b).

Box 6. Definition of police power

The **police power** is the inherent power of any independent government to enact laws that protect public health, safety and welfare. Police powers are reserved to the states by the Tenth Amendment of the U.S. Constitution.

N.H. RSA 674:16 (2011) grants police powers to municipalities by granting "the local legislative body of any city, town, or county … [the authority] to adopt or amend a zoning ordinance … for the purpose of promoting the health, safety, or the general welfare of the community."

To this end, the U.S. Supreme Court has stated that "[i]t seems to us that the property owner necessarily expects the uses of his property to be restricted, from time to time, by various measures newly enacted by the State in legitimate exercise of its police powers (Lucas at 1027)[.]" As the Court has "long recognized, some values are enjoyed under an implied limitation and must yield to the police power (Pennsylvania Coal Co. at 413)"; indeed, of all the powers of local government, the police power is "one of the least limitable" (*Lambert* at 228; Di*strict of Columbia at 1*49). N.H. jurisprudence clearly evinces this sentiment, as well; thus, an exercise of the state's police power that protects public health, welfare, and safety will not likely constitute a compensable taking (VLS, 2012:117).

Box 7. What's the *purpose* of regulation?

*"The publicity of the **rules** of an institution ensures that those engaged in it know what limitations on conduct to expect of one another and what kinds of actions are permissible. There is a common basis for determining mutual expectations"* (Rawls, 1971).

Though inherent to sovereignty, governments may only exercise the power to take private property pursuant to legislation (Cornell, 2017). In N.H., RSA 674:16 (Grant of Power) enables a municipality's authority to zone and the power to adopt a zoning ordinance—i.e., to properly regulate land uses **(Box 6)**.

Municipal authority to *properly* regulate land uses thus exists as a balance between private property rights **(Box 1 and Box 5)** and the purpose **(Box 3)** and power **(Box 6)** of government to promote the public health, welfare, and safety.

The question, then, is... *when?* When does a land use regulation become so burdensome that it crosses the threshold into a compensable taking of property by the government?

B. New Hampshire takings law

N.H. takings cases are fact-specific and generally follow federal law, although neither N.H. nor federal courts have established a "bright line" beyond which a regulation becomes a taking (VLS, 2012:99,105).

The N.H. Supreme Court determines the legality of regulations based on N.H. state law, using federal precedent only for comparison and to determine whether the Fifth Amendment provides any additional protection (*State v. Ball, 1983:232*). While N.H.'s highest state court has stated that the "Federal Constitution affords the plaintiffs no greater protection than does the [N.H.] Constitution (*Webster* at 438)," regulatory takings claims in New Hampshire should be examined under the N.H. and U.S. Constitutions (VLS, 2012).

In N.H., a **governmental regulation** can be a taking, even if the land is not physically taken, if it is an arbitrary or unreasonable restriction that substantially deprives the owner of the economically viable use of his or her property in order to benefit the public (*Burrows* at 597-98; *Smith* at 346; *Lucas* at 1015; *Bio Energy* at 157). However, when a municipal ordinance is challenged, there is a strong presumption that the ordinance is valid and, consequently, not lightly to be overturned by N.H. courts (VLS, 2012:61).

Step one: Court determines if the regulation affects a protected property right

The first step, then, for a New Hampshire and federal takings analysis is to determine whether the regulation affects a protected property right (VLS, 2012:100).

The N.H. Supreme Court defines **property** as "refer[ring] to a person's right to 'possess, use, enjoy and dispose of a thing and is not limited to the thing itself" (*Burrows* at 597; *Metzger at* 502).

If the regulation merely prohibits a land use that was never part of the owner's property rights in the first place, such as a nuisance activity or other prohibition under common law, the regulation will not result in a compensable taking (Lucas at 1029; VLS, 2012:100).

Step two: Court tests to determine whether the regulation constitutes a compensable taking

If the regulation does affect a property right, a municipality can be subject to a compensable "per se taking" claim in the rare situation where a regulation restricts "all economically beneficial or productive use of land," thereby effecting a complete or per se taking; or when a regulation goes "too far" and infringes on private property rights, effecting a partial taking ((Penn Central at 127; VLS, 2012:82).

Per se taking test

If the regulation restricts "all economically beneficial or productive use of land," there is a compensable per se (complete) taking (Lucas at 1015). This is equally true under the New Hampshire Constitution: especially onerous, arbitrary or unreasonable restrictions which substantially deprive the owner of the 'economically viable use of his land' in order to benefit the public in some way constitute a taking within the meaning of our New Hampshire (Burrows at 598).

Partial taking test

N.H. courts use a case-specific, fact-based partial taking test (based on the federal "Penn Central test" named for the landmark 1978 partial taking case in which the U.S. Supreme Court used "fairness factors" in its analysis Penn Central Transp. Co. v. New York City) that tends to favor regulation over compensation. Partial takings claims are evaluated based on: (1) the economic impact on the property owner; (2) the degree of interference with the owner's reasonable investment-backed expectation; and (3) the character of the occupation.

(1) Economic impact on the property owner

Similar to most federal courts who employ a "with or without" test that looks at the value of a property with or without the regulation, N.H. courts use a "before and after" comparison to measure the degree to which a government regulation diminishes a property's economically viable use (Quirk at 130-32). This test attempts to determine fair market value immediately before and immediately after the regulation (VLS, 2012). For most properties, N.H. courts use a comparable-sales approach to assess fair market value (VLA, 2012:106). For income-generating properties, N.H. courts may use a market-capitalization approach, or it may combine the methods (VLS, 2012:106).

(2) Owner's reasonable investment-backed expectations

N.H. courts have also indirectly applied the federal courts' rate-of-return approach to determining diminution of value of regulated income and investment properties (VLS, 2012:109). This approach assesses value based on the purpose for which the property had been purchased.

Once a court has determined a landowner has an initial expectation to use the property for a purpose that is prohibited by the regulation, it will ordinarily inquire into whether the expectation is objectively reasonable (VLS, 2012:112). The U.S. Supreme Court has adopted a three-part test to determine whether an expectation is reasonable and whether the regulation was foreseeable at the time of the acquisition of the property (Appolo Fuels Inc. at 1349). Under this test, individuals who claim property rights in a "heavily regulated field" typically have a difficult time establishing they have an objectively reasonable expectation the state will not enact new regulations that will affect their property. (Federal Housing Administration at 91). Thus, for example, N.H. legislation that identifies the Lamprey River as "Protected River" could influence the court's decisions on whether there was a reasonable investment-backed expectation regarding certain types of development in the Lamprey River watershed (VLS, 2012).

The rate-of-return approach may, to a lesser extent, attempt to account for a property owner's ability to recoup the original cost-basis under the regulation (Burrows at 601; VLS, 2012:). This method also applies to "existing use" cases and may favor the state in cases where property has significantly appreciated over time (VLS, 2012:109).

Finally, N.H. courts will look to the regulatory scheme currently in place to determine whether a claimant could have reasonably anticipated government action (Palazzolo at 633; Claridge at 752-53; VLS, 2012:114).

(3) Character of the government action

Like federal courts, N.H. courts evaluate the character of the government action by weighing the public interest served by the regulation against the private burden on an affected landowner (*Keystone Bituminous Coal Association* at 492; *Mugler* at 665; *Claridge* at 752; VLS, 2012:115-16). This definition of character is essentially a determination of whether a government action constitutes a taking based on whether the burden on a private property interest should be carried by the landowner or the public at large (VLS, 2012:115).

In sum, while the particular diminution of value measure that the court may use is difficult to predict, it will likely be tied to the factual attributes of the property in question and the regulatory circumstances behind the government action (VLS, 2102:110).

IV. CONCLUSION

The risk of municipal takings liability is low, so long as municipalities follow sound planning principles (VLS, 2013; Wake, 2013; SWA, 2013; RPC, 2013). Moreover, the federal government *encourages* communities to enact certain types of regulations designed to reduce floodplain hazards (VLS, 2013; RPC, 2013; Wake, 2013). Under federal floodplain guidelines, states and municipalities are encouraged to establish more stringent regulations above and beyond minimum federal requirements (VLS, 2013; Wake, 2013).

Additional Guidance

- A taking claim must be “ripe” for judicial review before the court will determine whether a regulation constitutes a compensable taking (VLS, 2012:90,120). That is, the claimant must at least have applied for and been denied a variance or special use permit before a court will hear the case.
- "Erroneous board decisions based on mistaken interpretations of valid regulations differ materially from technically precise applications of invalid ordinances; a mistaken board decision does not effect a taking when the erroneous decision resulted from misconstruction of otherwise valid restrictions" (*Dumont* at 10).

Recommendations

- Whether towns have the requisite **enabling authority** depends on the specifics of the regulation being imposed; municipalities should clearly identify the enabling statute that allows the enactment of the ordinance or regulation (VLS, 2012:9).
- ***Regulation creation:***
    - Indicate that the purpose of the regulation is to promote hazard mitigation and habitat and biological conservation, and make this clear in **the master plan** (VLS, 2012:10).
    - Enact regulations in a way that preserves some **economically viable use** of the land (VLS, 2012:10).
    - In New Hampshire, **scientific data is very rarely needed** to justify the enactment of ordinances. As long as you have a reasonable justification [for using climate projection maps, the maps will be upheld] (VLS, 2012:10).
    - A municipality might consider using the principle of **No Adverse Impact** as a standard when creating floodplain regulations to avoid takings claims (VLS, 2012:90,120). NAI is the principle that the action of one property owner may not adversely impact the flooding risk for other property owners.
- ***Master plan:***
    - The **master plan** provides the **rational nexus** between the goals and needs of a community and the regulatory tools that can be implemented to achieve those goals.
        - **Acknowledge scientific uncertainty upfront** in your master plan (VLS, 2012:36). By addressing the uncertainty of flood hazards in comprehensive plans, municipalities have the opportunity to acknowledge the unpredictability of future conditions, while at the same time emphasizing the importance of taking action despite uncertainty (VLS, 2012:36). Comprehensive plans can specifically address the impacts of increased storm intensity and the presence of flood hazards in the municipality (VLS, 2012:36). If a municipality chooses, it can also base all planning on future conditions, such as fully built-out watersheds (VLS, 2012:36). **The foundation**

for any proposed regulatory or non-regulatory flood hazard strategy must be provided in the master plan (VLS, 2012:36).

- If necessary, amend your master plan to:
  - include goals and policies for floodplain management that integrates buffers and other green infrastructure approaches (VLS, 2012:10), and
  - indicate that the purpose includes the "health, safety, and welfare" of citizens in the community (see **Box 6**) (VLS, 2012:10).

APPENDIX 1:

Most common takings-related concerns heard from participants in the Community Assessment of the *Buffer Options for the Bay* project

Definition of a regulatory taking:

- Confusion over definition of "reasonable use" = 4 mentions
- Confusion over definition of "regulatory taking" = 1 mention
- Confusion over "long-standing use" = 1 mention

Subtotal = 6 mentions

Definition of property rights:

- Nature and extent of N.H. municipalities' authority to set regulatory standards = 2 mentions
- Confusion over extent to which future regulations might interfere with private property rights = 1 mention

Subtotal = 3 mentions

Total = 9 mentions

APPENDIX 2:
Annotated bibliography & legal resources related to N.H. takings law

United States Constitution

U.S. Constitution, amend. V. ("No person shall […] be deprived of life, liberty, or property, without due process of law; nor shall private property be taken for public use, without just compensation.")

U.S. Constitution, amend. X. (Powers not delegated by the states to the United States and not forbidden to states are retained by states.)

U.S. Constitution, amend. XIV. (Amendment by which the taking and due process clause *inter* alia of the Fifth Amendment applies to the states.)

Federal statutes

Federal Water Pollution Control Act (a.k.a. Clean Water Act). 33 U.S.C. §1251 et seq. (1972). (Protects water quality by requiring monitoring and controlling discharges. The scope of the Act is limited to "navigable waters," but this has been broadly defined to include wetlands and areas directly adjacent to navigable waters.)

Rivers and Harbors Act of 1899. 33 U.S.C. §§ 401, 403 (1976). (Sections 9 and 10 grant the United States Army Corps of Engineers control over obstructions to "navigable waters.")

New Hampshire Constitution

N.H. Const., Art. 1. 1784. Equality; origin and object of government.
N.H. Const., Art. 2. 1784, revised 1974. Natural rights.
N.H. Const., Art. 3. 1784. Society, its organization and purpose.
N.H. Const., Art. 10. 1784. Right of revolution.
N.H. Const., Art. 12. 1784. Protection and taxation reciprocal.
N.H. Const., Art. 12-a. 1784. Power to take property limited.

New Hampshire statutes

General Authority and Administration

N.H. Rev. Stat. Ann. Ch. 31. Powers and Duties of Towns.
N.H. Rev. Stat. Ann. § 31:41-b. Hazardous Embankments.
N.H. Rev. Stat. Ann. § 31:92 Taking of Land.
N.H. Rev. Stat. Ann. § 31:92-a. Water Pollution.
N.H. Rev. Stat. Ann. § 149-I:1-25. Sewers.
N.H. Rev. Stat. Ann. § 432:3. State Plan.

N.H. Rev. Stat. Ann. § 483:2. [New Hampshire Rivers Management and Protection] Program Establish; Intent.
N.H. Rev. Stat. Ann. § 483:15. Rivers Designated for Protection.
N.H. Rev. Stat. Ann. § 483-B. Shoreland Water Quality Protection Act.
N.H. Rev. Stat. Ann. § 483-B:8. Municipal Authority.
N.H. Rev. Stat. Ann. § 483-E:3. Coastal Risk and Hazards Commission.
N.H. Rev. Stat. Ann. § 485-A:13. Water Discharge Permits.
N.H. Rev. Stat. Ann. § 498-A:1-31. Eminent Domain Procedure Act.
N.H. Rev. Stat. Ann. § 674:16. Grant of [Police] Power.
N.H. Rev. Stat. Ann. § 674:20 Districts.
N.H. Rev. Stat. Ann. § 674:21-a. Development Restriction Enforceable.

Regulation and Planning

N.H. Rev. Stat. Ann. § 21-O. New Hampshire Department of Environmental Services water quality responsibilities.
N.H. Rev. Stat. Ann. § 483:10. Rivers Corridor Management Plans.
N.H. Rev. Stat. Ann. § 485-A:17. Terrain Alteration.
N.H. Rev. Stat. Ann. § 674:2. Master Plan Purpose and Description.
N.H. Rev. Stat. Ann. § 674:3. Master Plan Preparation.
N.H. Rev. Stat. Ann. § 674:16. "Flexible and Discretionary" Zoning.
N.H. Rev. Stat. Ann. § 674:17. Purposes of Zoning Ordinances.
N.H. Rev. Stat. Ann. § 674:21. Innovative Land Use Controls.
N.H. Rev. Stat. Ann. § 674:21(j). "Environmental Characteristics" Zoning.
N.H. Rev. Stat. Ann. § 674:36. Subdivision Regulations.
N.H. Rev. Stat. Ann. § 674:44. Site Plan Review Regulations.
N.H. Rev. Stat. Ann. § 674:55. Wetland Regulations.
N.H. Rev. Stat. Ann. § 674:56(I). Floodplain Zoning.
N.H. Rev. Stat. Ann. § 674:56(II). Fluvial Erosion Hazard Zoning.
N.H. Rev. Stat. Ann. § 674:57. FEMA Flood Insurance Rate Maps (and 44 C.F.R. 67.5).

Environmental

N.H. Rev. Stat. Ann. § 483:2. Fill and Dredge in Wetlands.
N.H. Rev. Stat. Ann. § 483-B:9. Minimum Shoreland Protection Standards.
N.H. Rev. Stat. Ann. § 674:55. Wetlands.
N.H. Env-Wt. Administrative Rules.

Federal case law

Agins v. Tiburon, 447.U.S. 255, 260 (1980). ("Land-use regulation does not effect a taking if it "substantially advance[s] legitimate state interests" and does not "den[y] an owner economically viable use of his land.")

Appolo Fuels, Inc. v. U.S., 54 Fed. Cl. 717, 1349 (2002).

Armstrong v. United States, 364 U.S. 40, 80 S. Ct. 1563, 4 L. Ed. 2d 1554 (1960). (The Fifth Amendment's guarantee that private property shall not be taken for a public use without just compensation was designed to bar Government from forcing some people alone to bear public burdens which, in all fairness and justice, should be borne by the public as a whole.)

Boom Co. v. Patterson, 98 U.S. 403, 406 (1879). ("Eminent domain "appertains to every independent government. It requires no constitutional recognition; it is an attribute of sovereignty.")

Chicago, Burlington & Quincy RR. Co. v. Chicago, 166 U.S. 226 (1897).

District of Columbia v. Brooke, 214 U.S. 138, 149 (1909). "[T]he police power, one of the most essential of powers, at times the most insistent, and always one of the least limitable of the powers of government."

Dolan v. City of Tigard, 512 U.S. 374, 114 S. Ct. 2309, 129 L. Ed. 2d 304 (1994).

Federal Housing Administration v. Darlington, Inc., 358 U.S. 84, 91 (1958).

Heiss Case, 141 Ill. 35, 31 N.E. 138, 141 Il. 35 (1892).

Kaiser Aetna v. United States, 444 U.S. 164, 261, 262 (1979). ("[N]o precise rule determines when property has been taken.)

Kelo v. New London, 545 U.S. 469, 489 (2005). ("We emphasize that nothing in our opinion precludes any State from placing further restrictions on its exercise of the takings power. Indeed, many States already impose "public use" requirements that are stricter than the federal baseline.)

Keystone Bituminous Coal Association v. DeBenedictis, 480 U.S. 470, 488, 492 (1987). (Recognizing that property law restricts use of property that is to the detriment of the public at large or individual property interest (citing Mugler, 123 U.S. at 665) and that determining the legitimacy of state action "necessarily requires a weighing of private and public interests" (citing Agins, 447 U.S. at 260-261).).

Lambert v. California, 355 U.S. 225 (1957). (Of all the powers of local government, the police power is "one of the least limitable.")

Lucas v. South Carolina Coastal Council, 505 U.S.1003, 1015-1019, 1024, 1027, 1029-31 (1992). (1015-1019: Established a bright line rule for the relatively rare *per se* or complete taking, which is where a state regulation deprives an owner of all economically beneficial use of his property. 1027: "Where the State seeks to sustain regulation that deprives land of all economically beneficial use, we think it may resist compensation only if the [...] proscribed use interests were not part of his title to begin with. This accords, we think, with our "takings" jurisprudence [... and] the understandings of our citizens regarding the content of, and the State's power over, the "bundle of rights" that they acquire when they obtain title to property. It seems to us that the property owner necessarily expects the uses of his property to be restricted, from time to time, by various measures newly enacted by the State in legitimate exercise of its police powers;

"[a]s long recognized, some values are enjoyed under an implied limitation and must yield to the police power.")

Metzger v. Town of Brentwood, 117 N.H. 497, 502 (N.H. 1977).

Mugler v. Kansas, 123 U.S. 623, 665 (1887). ("A prohibition simply upon the use of property for purposes that are declared, by valid legislation, to be injurious to the health, morals, or safety of the community, cannot, in any just sense, be deemed a taking or an appropriation of property for the public benefit.")

Nectow v. Cambridge, 277 U.S. 183, 188 (1928). (The application of a general zoning law to particular property effects a taking if the ordinance does not substantially advance legitimate state interests.)

Nollan v. California Coastal Commission, 483 U.S. 825 (1987). ("We have long recognized that land-use regulation does not effect a taking if it "substantially advance[s] legitimate state interests" and does not "den[y] an owner economically viable use of his land" quoting Agins v. Tiburon, 447 U. S. 255, 260 (1980)).

Palazzolo v. Rhode Island, 533 U.S. 606, 633 (2001). (O'Connor, J., concurring) ("the regulatory regime in place at the time the claimant acquires the property at issue helps to shape the reasonableness of those expectations.")

Penn Central Transp. Co. v. New York City, 438 U.S. 104, 127, 138, n.36 (1978). (The case which established the court's economic balancing test to determine occurrence of a taking. "[A] use restriction may constitute a `taking' if not reasonably necessary to the effectuation of a substantial public purpose.")

Pennsylvania Coal Co. v. Mahon, 260 U.S. 393, 413, 415 (1922). (A case in which the U.S. Supreme Court held that whether a regulatory act constitutes a taking requiring compensation depends on the extent of diminution in the value of the property. The decision thereby started the doctrine of regulatory taking.)

Pennsylvania Mutual Life Insurance Co. v. Heiss, 141 Ill. 35, 31, N.E. 138 (1892). (Eminent domain is "an essential attribute of sovereignty, inherent in every independent government, and to be exercised in the discretion of the sovereign power, to promote the general welfare of the people.")

Ruckelshaus v. Montsanto Co., 467 U.S. 986, 1014 (1984). (Public use requirement is coterminous with the scope of police power.)

United States v. Carmack, 329 U.S. 230, 241–42 (1946). ("The Fifth Amendment … says 'nor shall private property be taken for public use, without just compensation.' This is a tacit recognition of a preexisting power to take private property for public use, rather than a grant of new power.")

United States v. Lopez, 514 US 549, 591 fn. 4 (1995).

United States v. Willow River Power Co., 324 U.S. 499, 502 (1945). ("It is clear, of course, that head of water has value and that the Company has an economic interest in keeping the [river dammed up]. But not all economic interests are "property rights"; only those economic advantages are "rights" which have the law back of them, and only when they are so recognized may courts compel other to forebear from interfering with them or to compensate for their invasion.")

Village of Euclid, et al. v. Ambler Co., 272 U. S.365, 395-397 (1926). (The seminal decision on the weighing of private and public interests where, despite alleged diminution in value of the owner's land, the Court held zoning laws facially constitutional, because they bore a substantial relationship to the public welfare, and their enactment inflicted no irreparable injury upon the landowner.)

Wisconsin v. Yoder, 406 U.S. 205, 220 (1972). ("It is true that activities of individuals, even when religiously based, are often subject to regulation by the States in the exercise of their undoubted power to promote the health, safety, and general welfare, or the Federal Government in the exercise of its delegated powers (at 220)."

New Hampshire case law

Asselin v. Town of Conway, 137 N.H. 368, 371, and 371-372 (1993); *Boulders v. Town of Strafford*, 153 NH 633, 903 A. 2d 1021; *see also* RSA 674:16(I) (1996). ("The State zoning enabling act grants municipalities broad authority to pass zoning ordinances for the health, safety, morals and general welfare of the community. Furthermore, a municipality may exercise its zoning power solely to advance aesthetic values because the preservation or enhancement of the visual environment may promote the general welfare.")

Biggs v. Town of Sandwich, 124 N.H. 421, 427, 470 A.2d 928 (1984). (The master ruled that the plaintiffs could not properly make a claim for inverse condemnation because of their prior knowledge of the proposed ordinance and their lack of good faith in proceeding with construction of the septic system, and because the repurchase agreement protected them from suffering any compensable damage. The record indicates that any hardship the plaintiffs may have suffered was self-imposed.)

Burrows v. City of Keene, 121 N.H. 590, 597-98 (1981). (Keene's designation of plaintiffs' property as part of a conservation district constituted a taking requiring compensation under the State Constitution, because [a] the right to just compensation for a taking of property necessarily limits the police power and [b] that the government cannot, through regulation, indirectly effect a taking without paying compensation.)

Chester Rod & Gun Club v. Town of Chester, 152 N.H. 577, 580, 883 A.2d 1034 (2005). ("Our standard of review is well-settled: We will uphold the trial court's decision unless the evidence does not support it or it is legally erroneous. For its part, the trial court must treat all factual findings of the ZBA as prima facie lawful and reasonable. RSA 677:6 (2008). It may set aside a ZBA decision if it finds by the balance of probabilities, based on the evidence before it, that the ZBA's decision was unreasonable.")

City of Portsmouth v. Boyle, 8 A.3d, 37 (2010). (City commenced a zoning enforcement action against Boyle alleging that he unlawfully clear cut trees within a wetlands buffer zone. The city sought an injunction and an order to conduct restoration efforts (*see* RSA 676:15) and requested civil penalties, attorney's fees, and costs (*see* RSA 676:17, I, II, Supp.2009). The court affirmed that City had failed to demonstrate that Boyle's clear cutting activity violated the city's zoning ordinance.)

Claridge v. Wetlands Board, 125 N.H. 745, 747-48, 485 A.2d 287, 291-92 (N.H. 1984). (Noting that land that could be sold to abutters supported the conclusion that the property continued to have economic value. Upheld a finding that filling the salt marsh in question would destroy much of the ecological value of the land by "irreparably diminish[ing] the marsh's nutrient-producing capability for coastal habitats and marine fisheries" (485 A.2d at 292). Court also held that because the owners had both constructive and actual notice when they bought the property of State and municipal regulations which might interfere with their intended use of the property, the board's denial of their petition did not thwart substantial, justified expectations (125 N.H. at 751-52; 485 A.2d at 291-92). Moreover, the court "did not consider the plaintiffs' burden to be unreasonably onerous since they were in the same position as other wetlands owners who were unable to build upon their property without extensive landfill. The burden upon the plaintiffs in *Claridge* was simply the type of risk "which [they] chose to take in buying this lot with notice of regulatory impediments (125 N.H. at 753; 485 A.2d at 292)."

Dugas v. Town of Conway, 125 N.H. 175, 182, 480 A.2d 71 (1984). ("Reasonable regulations, aimed at promoting the health, safety and general welfare of the community, may not require compensation[.]" "The police power is restricted by the express provisions of State statutes and by the specific guarantees of the Bill of Rights of our State Constitution (125 N.H. at 182)."

Dumont v. Town of Wolfeboro, 137 N.H. 1, 10-11 (1993). ("Erroneous board decisions based on mistaken interpretations of valid regulations differ materially from technically precise applications of invalid ordinances; a mistaken board decision does not effect a taking when the erroneous decision resulted from misconstruction of otherwise valid restrictions.")

Fischer v. New Hampshire State Building Code, 914 A. 2d 1234, 1237 (2006). ("As the Washington Supreme Court aptly stated: 'There is no such thing as an inherent or vested right to imperil the health or impair the safety of the community.... It would be a sad commentary on the law, if municipalities were powerless to compel the adoption of the best methods for protecting life in such cases simply because the confessedly faulty method in use was the method provided by law at the time of its construction.' We concur with this analysis.")

Funtown v. Town of Conway, 127 N.H. 312, 318, 499 A.2d 1337 (1985). (Plaintiff's affidavit claimed abutters were interested in buying his property, thereby failing to demonstrate that a genuine issue of material fact existed as to whether the value of his property has been substantially destroyed.)

Huard v. Town of Pelham, 986 A.2d 460, 159 N.H. 567 (2009).

Lachapelle v. Goffstown, 107 N.H. 485, 489 (1967). ("Zoning by its nature restricts and regulates the use of land and that is one of the reasons why this court has consistently placed a strict construction on provisions under which attempts are made to expand, multiply or perpetuate nonconforming uses.")

Loundsbury v. City of Keene, 122 N.H. 1006 (1982). ("Certainly, a town may proscribe harmful property-related activity without providing compensation." "A provision requiring the discontinuance of a nonconforming use will be deemed unreasonable if no public purpose supports it. Additionally, even when a valid public purpose [does] exist[], the application of a zoning provision which is not directed at harmful activity and which substantially deprives an owner of the use of his land constitutes a "taking" requiring the payment of just compensation (122 N.H. at 1010).")

McKenzie v. Town of Eaton Zoning Board, 917 A. 2d 193, 154 N.H. 773 (2007).

Pennichuck Corp. v. City of Nashua, 152 N.H. 729, 733-34, 886 A.2d 1014 (2005). ("Limitations on use create a taking if they are so restrictive as to be economically impracticable, resulting in a substantial reduction in the value of the property and preventing the private owner from enjoying worthwhile rights or benefits in the property.")

Quirk v. Town of New Boston, 140 N.H. 124, 129, 130-32 (N.H. 1995). ("In enacting a zoning regulation, a town may consider the knowledge of town selectmen and planning board members concerning such factors as traffic conditions and surrounding uses resulting from their familiarity with the area involved (140 N.H. at 129)." "While there are several methods to measure the degree to which a government regulation diminishes a property's economically viable use, N.H. courts use a "before and after" comparison, which attempts to determine the market value immediately before and immediately after the regulation is imposed on the property (140 N.H. at 130-32).")

Richardson v. Town of Salisbury, 123 N.H. 93, 96, 455 A.2d 1059, 1061 (1983); RSA 31:78 (Supp. 1983). ("Moreover, the trial court must let the board's denial stand unless it finds "by the balance of the probabilities, on the evidence before it, that the decision was unlawful or unreasonable.")

Sibson v. State, 115 N.H. 124, 248, 336 A. 2d 239 (1975). (Court recognized the environmental uniqueness of wetlands and its importance to the public health and welfare. And that, unlike many other property regulation situations, the filling of wetlands alters the property itself and changes its basic character, to the detriment of the public good. "An owner of land has no absolute and unlimited right to change the essential natural character of his land so as to use it for a purpose for which it was unsuited in its natural state and which injures the rights of others." "Sibson recognized that the validity of a regulation is determined by balancing the importance of the public benefit against the seriousness of the restriction on private rights.")

Smith v. Town of Wolfeboro, 136 N.H. 337, 346, 615 A.2d 1252 (1992).

State v. Ball, 124 N.H. 226, 232 (1983). ("[A]ny decision we reach based upon *federal* law is subject to review by the United States Supreme Court, whereas we have unreviewable authority to reach a decision based on articulated adequate and independent State grounds. Since this court is the final authority on New Hampshire law, initial resolution of State constitutional claims insures that the party invoking the protections of the New Hampshire Constitution will receive an expeditious and final resolution of those claims. Therefore, we will first examine the New Hampshire Constitution and only then, if we find no protected rights thereunder, will we examine the Federal Constitution to determine whether it provides greater protection.")

Taylor v. Town of Plaistow, 152 N.H. 142 (2005). ("In enacting a zoning regulation, a town may consider the knowledge of town selectmen and planning board members concerning such factors as traffic conditions and surrounding uses resulting from their familiarity with the area involved.")

Webster v. Town of Candia, 146 N.H. 430, 438 (2001). (""[T]he Federal Constitution affords the plaintiffs no greater protection than does the [NH] Constitution (146 N.H. at 438)." "If it can be and is reasonably determined by the selectmen that the atmosphere of the town ... will be maintained if the proposed structure is erected on the land bordering the town common, then they are bound to approve it. If it is reasonably determined that that atmosphere will not be maintained, or if it cannot reasonably be determined that it will, then the structure is prohibited.")

Permits:

New Hampshire Programmatic General Permit, Department of the Army. N.H. PGP (III): "Activities Covered: Work and structures that are located in, or that affect, navigable waters of the United States...(regulated by the Corps under Section 10 of the Rivers and Harbors Act of 1899); The discharge of dredged or fill material into waters of the U.S. (regulated by the Corps under Section 404 of the Clean Water Act)." *N.H. PGP (IX)20):* "Bank Stabilization: Projects involving construction or reconstruction/maintenance of bank stabilization structures within Corps jurisdiction should be designed to minimize environmental effects, effects to neighboring properties, scour, etc. to the maximum extent practicable. Applicants must use the least intrusive method to stabilize the bank... and the following sequential minimization process: diversion of water, vegetative stabilization, stone-sloped surfaces, and walls. Vertical bulkheads should only be used in situations where reflected wave energy can be tolerated. This generally eliminates bodies of water where the reflected wave energy may interfere with or impact on harbors, marinas, or other developed shore areas. A revetment is sloped and is typically employed to absorb the direct impact of waves more effectively than a vertical seawall. It typically has a less adverse effect on the beach in front of it, abutting properties and wildlife." *N.H. PGP (IX)(25):* "Environmental Functions and Values: The permittee shall make every reasonable effort to 1) carry out the construction or operation of the work authorized herein in a manner that minimizes adverse impacts on fish, wildlife and natural environmental values..."

Note: Section 404 of the Federal Water Pollution Control Act (a/k/a Clean Water Act) deals specifically with filling, both temporary and permanent, into "waters of the United States."

Note: Section 10 of the Rivers and Harbors Act of 1899 typically requires an Army Corps of Engineers (ACOE) permit. ACOE's focus is on existing and prevailing navigational uses. "Navigable waters" are subject to ebb and flow of the tide.

New Hampshire Programmatic Specific Permit, Department of the Army.

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