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Assessing the Benefits of Wetland Restoration:

A Rapid Benefit Indicators Approach for Decision Makers

Office of Research and Development
National Health and Environmental Effects Research Laboratory

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Assessing the Benefits of Wetland Restoration:

A Rapid Benefit Indicators Approach for Decision Makers

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Notice and Disclaimer

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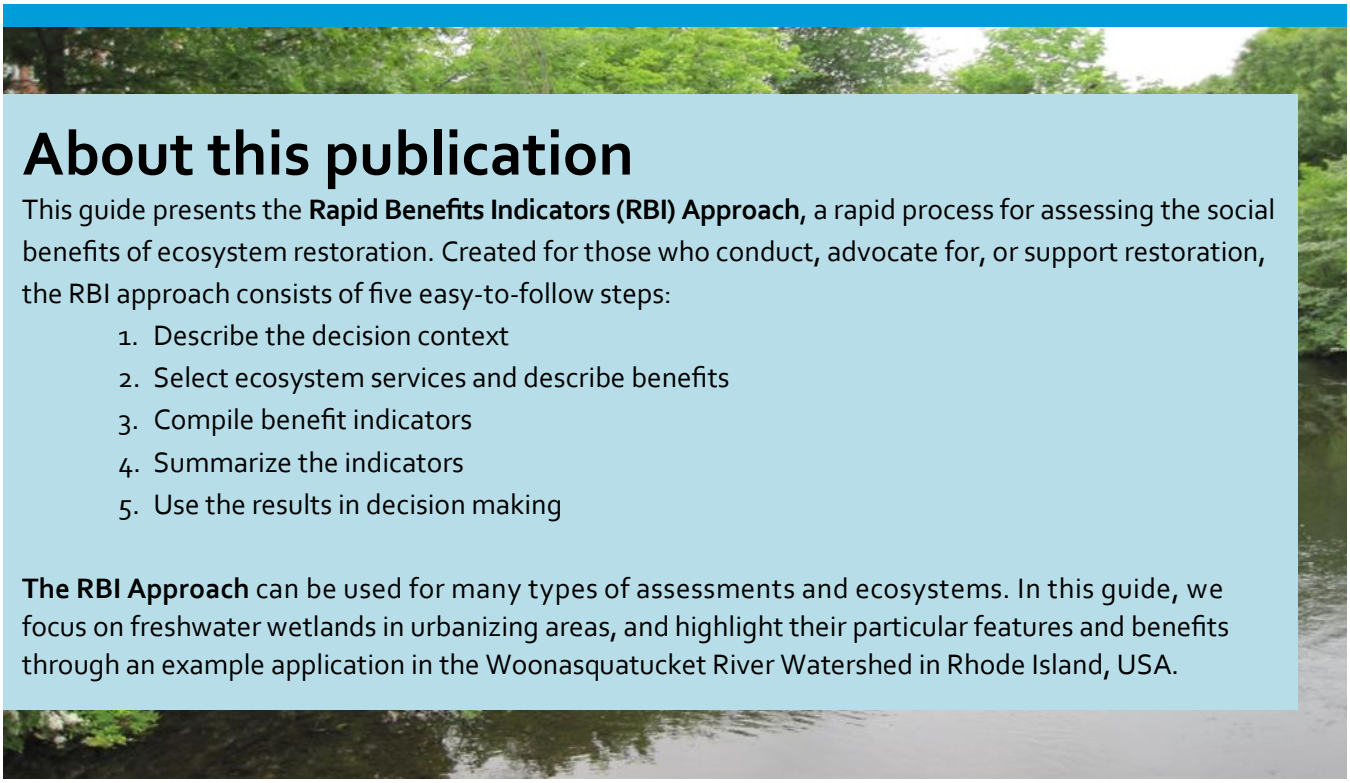

About this publication

This guide presents the **Rapid Benefits Indicators (RBI) Approach,** a rapid process for assessing the social benefits of ecosystem restoration. Created for those who conduct, advocate for, or support restoration, the RBI approach consists of five easy-to-follow steps:

1. Describe the decision context
2. Select ecosystem services and describe benefits
3. Compile benefit indicators
4. Summarize the indicators
5. Use the results in decision making

The RBI Approach can be used for many types of assessments and ecosystems. In this guide, we focus on freshwater wetlands in urbanizing areas, and highlight their particular features and benefits through an example application in the Woonasquatucket River Watershed in Rhode Island, USA.

Photo by: Rick McKinney

Acknowledgments

We would like to thank the many people who have provided information, feedback, and reviews that have improved the quality of this approach and Guidebook. They include Alicia Lehrer of the Woonasquatucket River Watershed Council; Caitlin Chafee of RI Coastal Resources Management Council; Marla Stelk of the Association of State Wetland Managers; Katelyn Szura, Nicole Gutierrez, Patricia DeCastro, David Martin, Kate Mulvaney, Chuck Lane, Jim Latimer, Tim Gleason, and Wayne Munns of US EPA; Meghan Nightingale; and the 27 restoration managers interviewed for this project.

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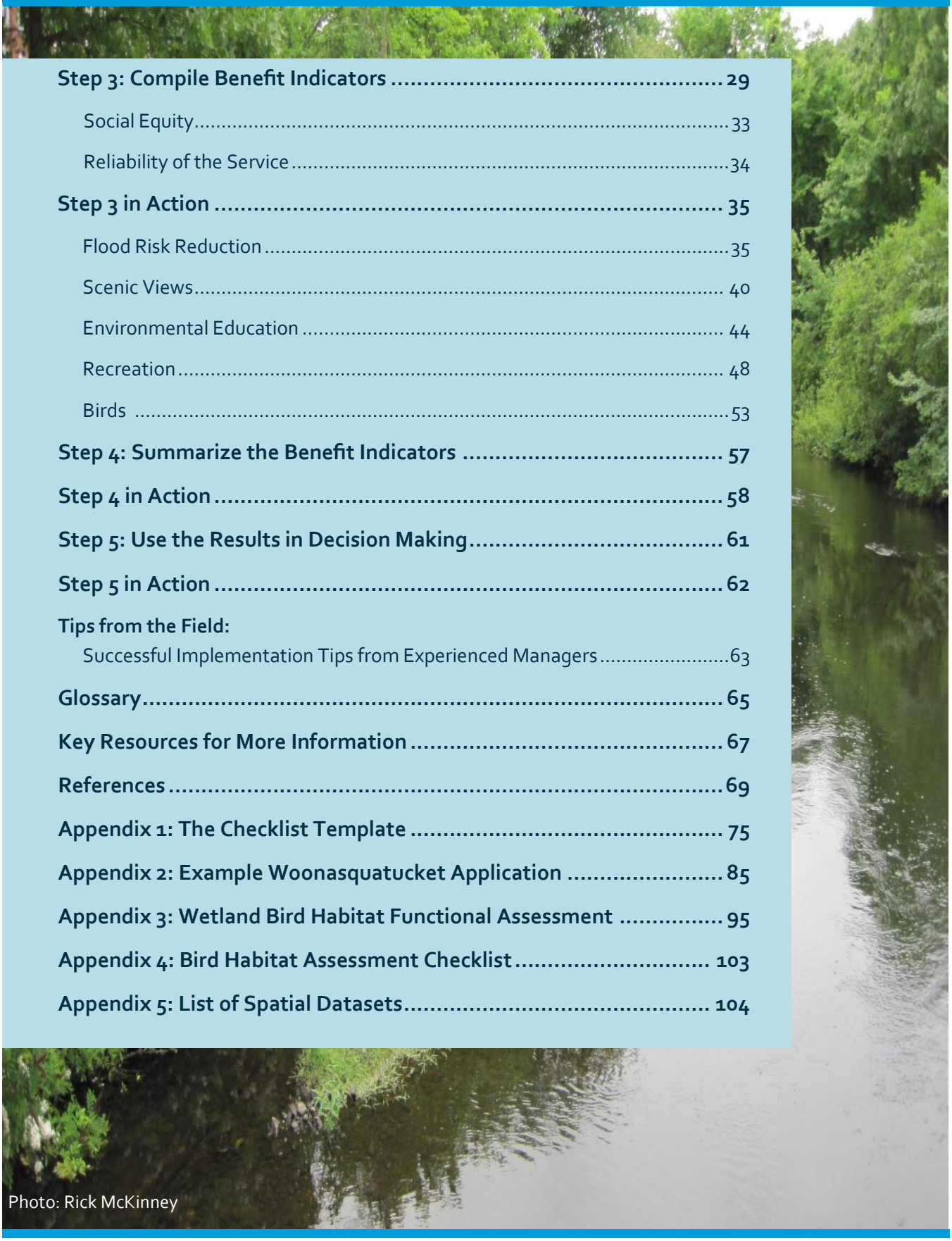


Photo: Rick McKinney

Photo by: Rick McKinney

How this guide can help you

This guide presents the **Rapid Benefits Indicators (RBI) Approach**, an easy-to-use process for assessing wetland restoration using non-monetary benefits indicators. The results of the RBI Approach complement the information gleaned using assessments of ecological functions by adding information about benefits to people.

The information presented in this guide will help you use the RBI Approach to:

- √ Prioritize restoration sites or projects
- √ Decide which projects to fund
- √ Screen projects that may require further evaluation
- √ Justify funding requests
- √ Assess who may benefit most from a project
- √ Inform people about the benefits of restoration

The RBI Approach does not estimate dollar values of benefits, and does not result in a single numeric score for each site. Methods that apply dollar values are complex and data are often lacking for many important ecosystem services. We have attempted to fill a gap by providing a way to rapidly estimate and quantify benefits using readily available data.

The RBI Approach is a multidimensional and disaggregated method, which compiles information in a systematic way to inform decisions. It may be used as a first step towards monetary valuation or towards a single score, but can be used on its own in many contexts, such as those listed above.

Whether you are a federal, state, or local manager, or a member of a watershed group, community group or funding organization, the RBI Approach can help you assess the social benefits from ecological restoration and make a scientifically, economically, and socially sound restoration decision.

Quick Start Information

The RBI Approach

In this guide, we walk you through the RBI Approach, which is a rapid assessment process for evaluating the benefits of ecosystem services. The RBI Approach consists of five steps, each briefly described below:

Step 1 **Describe the decision context**

This step helps you to clarify the decision context by prompting you to gather important background information applicable to the restoration site(s) under consideration.

Step 2 **Select and describe ecosystem services and benefits**

This step helps you identify the most relevant ecosystem services and their associated benefits for the potential restoration site(s). In this step, you will compile basic information about each of the benefits, in preparation for Step 3. This includes information about any possible concerns or "disservices" that may result from restoration, and information about people's proximity to the ecosystem services, which helps to determine who will benefit.

Step 3 **Compile benefit indicators**

The focal point of the RBI Approach, this step evaluates who benefits and how much they are likely to benefit from the services identified in Step 2. You will assess benefits of the services you selected in Step 2 by answering a series of questions. This will provide you with a set of benefit indicators—quantifiable, non-monetary measures of how people benefit from the selected ecosystem services. The main questions that are used to compile benefit indicators are:

1. Can people benefit from an ecosystem service?
2. How many people benefit?
3. How much are people likely to benefit?
4. What are the social equity implications?
5. How reliable are benefits expected to be over time?

The first two questions are required for the most basic assessment of benefits, and the third adds more information regarding the magnitude of benefits. Questions 4 and 5 address other important aspects of benefits.

Step 4 **Summarize the indicators**

This step assembles the results of your work in Step 3, and helps you make sense of what you have done.

Step 5 **Use the results in decision making**

Having applied the RBI Approach, this step helps you use your results to inform your decision, and gives you tips on presenting your results to team members, stakeholders, and the general public.

Each step is introduced by an overview section that summarizes the step and how to apply it. Following the full walkthrough of each step, you will find pages showing the "Step in Action" to demonstrate how the step is applied in a real-world scenario. Appendix 2 includes a complete comparison of two sites using the RBI approach from the Woonasquatucket River Watershed, Rhode Island, USA, to demonstrate how the RBI approach could be used to compare two restoration sites for funding prioritization.

The Checklist √

This guide corresponds with a simple checklist assessment form (located in Appendix 1 and the Excel® file that accompanies this guide) that prompts you to fill in your responses to each of the RBI Approach's questions. Feel free to fill in the checklist as you read through each step if you have existing, readily available data (for a simpler assessment). Or, read through the guidebook and fill in the checklist after gathering more technical data (for a more detailed analysis).

Features in this Guide

A set of preselected ecosystem services and benefits that wetlands provide

The set of ecosystem services we feature include some of the fundamental ecosystem services that wetlands provide. You can use these as starting points for your assessment, or as examples to see how the RBI Approach works so that you may then apply it to other services and benefits.

Examples of assessing social benefits using indicators for each ecosystem service

These benefits and their indicators are used to assess the ecosystem services we include in the guidebook.

Comparison example using two sites

We provide an example comparing two sites in the Woonasquatucket River Watershed in Rhode Island, illustrating how the RBI Approach can be applied.

Discussion of ways to engage stakeholders and the public

Engaging the public and stakeholders is a critical piece of any restoration project. We summarize some of the lessons we learned from interviews with 27 restoration managers in Rhode Island.

Discussion of ways to address concerns and possible disservices resulting from restoration

Often, people assume that every outcome of a restoration will be perceived as positive by the public. In talking with managers, we found that managers were often surprised by the perceptions of, and concerns about, disservices that might result from restoration.

Tips from the field

We provide a summary of some of the critical lessons learned by managers when they conducted restorations.

A glossary of commonly-used terms related to evaluating benefits of ecosystem services

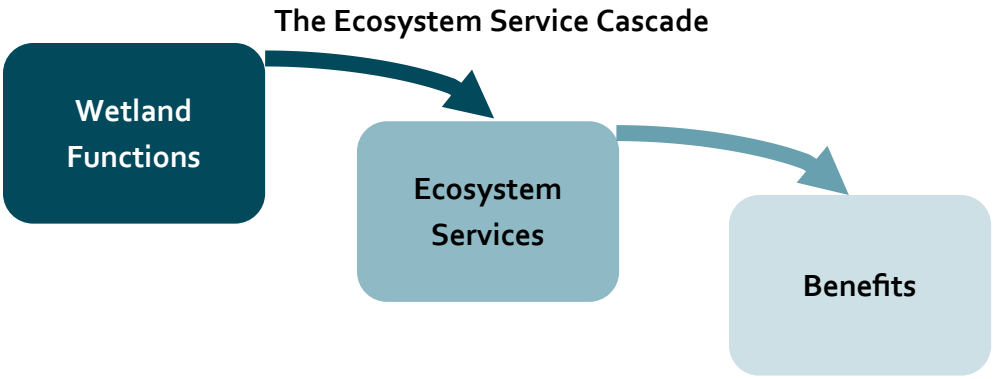
The glossary defines some of the commonly-used terms related to ecosystem services and their benefits, particularly with regard to wetlands.

A functional assessment tool for bird habitat (Appendix 3)

We have developed a functional assessment tool specifically for bird habitat, to demonstrate how one might develop a functional assessment tool for a specific ecosystem service.

Please note, the RBI Approach does require some effort on your end. The level of analysis necessary to apply the RBI will depend on your decision context. If you walk through each step, gather the suggested resources, enter your results in the checklist, and refer to the Steps in Action pages and additional resources provided in this guide, you will be able to produce a simple yet impactful site analysis that will make your restoration decision clearer for you and those who care.

How are Benefits from Wetlands Produced?



Function	Service	Benefits
Retaining or slowing water	Storm water regulation (affects surface runoff and flood waters, and downstream water quality)	Reduced flood risks to people Valued uses of improved downstream water quality
Characteristics of the system (multiple functions)	Scenic landscapes	Aesthetic enjoyment
Characteristics of the system (multiple functions)	Learning opportunities	Nature study, connection to nature
Bird habitat	Birds that people enjoy	Bird watching, hearing birds
Characteristics of the system (multiple functions)	Recreational opportunities	Recreational activities
Support for rare species or habitats	Rare or unique species or habitats	Value of knowing these exist

The table above shows how functions, services, and benefits are related.

The Ecosystem Service Cascade (Potschin and Haines-Young 2011) illustrates the linked flow from functions to services to benefits. Wetland functions or processes are the physical, chemical, and biological interactions within the ecosystem that produce ecosystem services: the ecological outcomes that people value. These are the aspects of nature that contribute to people's health, well-being, and enjoyment. Through people's interactions with them, wetlands provide a host of services and benefits to people.

Some ecosystem services and their benefits are valued because people directly enjoy or consume them (like fish or clean drinking water); some are valued because they reduce risks to people and property (like capture of water that can reduce flooding) or because they enhance health and well-being in other less tangible ways; and some are valued simply for the knowledge that they exist and may continue to exist for the benefit of future generations (like rare species of animals or plants).

Services and Benefits Addressed in this Guide

This guide addresses the following important services and benefits provided by wetlands in urbanized areas. We selected these because:

- They may be provided by relatively small, urban sites
- They are relevant to our example watershed
- They were mentioned in our interviews with managers

Wetlands can provide other services, and multiple types of benefits may result from each service. We are not providing indicators for a comprehensive set of freshwater wetlands' benefits, but are focusing on this subset of possible benefits. Local managers mentioned other services/benefits that could be important in urbanizing areas, including micro-climate regulation, reduced need for gray infrastructure, improved water quality, community vitality, wildlife habitat, and non-use values. Still others may be important in your watershed. The approach we illustrate can be applied in a similar way to other services and benefits. For more detailed information on defining and classifying ecosystem services and benefits, see US EPA (2015) and Landers and Nahlik (2013).

Ecosystem Service		How people benefit
	**Flood water regulation**	**Reduced Flood Risk:** The risks from floods to people and structures are reduced.
	**Scenic landscapes**	**Scenic Views:** People can enjoy scenic views.
	**Learning opportunities**	**Environmental Education:** People can benefit from studying nature or from enhanced connection to nature.
	**Recreational opportunities**	**Recreation:** People can enjoy recreation
	**Birds**	**Bird Watching:** People can watch or hear birds.

Icons by Piotrek Chuchla, Luis Prado and Matt Steele, the nounproject.com

This Approach vs. Existing Approaches

Many existing functional assessment approaches and tools evaluate wetlands based on how well they perform functions that provide ecosystem goods and services (King et. al. 2000 and King and Price 2004 list many of these). However, few functional approaches address how people benefit from those ecosystem services. The RBI Approach assesses how the people around a restoration site may benefit from ecosystem services that the site provides. It was developed to complement an existing functional assessment developed for freshwater wetlands (Miller and Golet 2001), and can be used in conjunction with results of this and other functional assessments.

Existing economic valuation approaches monetize the value of wetlands to people, but such estimates are context- and location-specific and typically require substantial resources to conduct. Recognizing the limitations of economic valuation, indicator-based studies have been used to assess the benefits and values of mitigation trades or compensatory restoration, in situations where wetlands are restored to compensate for losses due to development or environmental damage (King et. al. 2000; King and Price 2004; Wainger et al. 2001; Wainger et al. 2010).

The RBI Approach uses non-monetary benefit indicators to make assessments more rapid and less resource intensive. The RBI Approach is designed to use widely available data to ensure it is transferable outside of this case study. The principles and questions used in the RBI Approach are also transferable to other types of ecosystems.

The RBI Approach is grounded in economic theory and compatible with methods used by environmental economists to value ecosystem services. Research in environmental economics has shown that certain factors, which represent people's preferences and scarcity, are important determinants of the value of a good or service in relation to other things that people also value (including other goods or services, time, and money). We have incorporated these important factors into a set of questions that, together, give an overview of the big picture of ecosystem service benefits.

What do we mean when we say " value"?

There are many aspects of value and ways to define value. these include:

Values in wetlands literature – Often defined broadly in terms of benefits to either the environment or to people, these values don't necessarily depend on human appreciation.

Values in economics – Economic value depends on relative importance to people, compared to other things they might spend time or money to enjoy

Values in broader social science – These values may include other socio -cultural aspects of value, such as equity or other ethical concerns.

Photo by: Rick McKinney

Overview of the RBI: Steps and Guiding Questions

Core Steps

1 Describe the decision context

a. What are the objectives and geographic scope of the decision?

b. Who is affected by the decision?

c. What are the important needs of affected people?

d. Is a rapid assessment appropriate?

e. What degree of change is expected from the restoration?

2 Select and describe ecosystem services and benefits

a. Which ecosystem services are most relevant to the decision?

b. Which benefits of these services are important?

c. What are the general characteristics of each service and its benefits?

3 Compile benefit indicators

a. Are people able to receive benefits?

b. Who receives benefits?

c. How does the value of each benefit compare across sites?

d. How reliable are benefits over time?

4 Summarize the indicators

a. What are the results of the assessment?

5 Use the results in decision making

a. Which site(s) should be restored, or which restoration action(s) should be implemented?

b. How can the information that was compiled be best communicated?

Page Legend

Step Pages

These pages describe each step.

Step -in -Action Pages

These pages present examples for applying each step, using the Woonasquatucket Watershed and our 5 selected services and benefits.

Additional Information Pages

These pages expand on topic areas related to the RBI.

Symbols

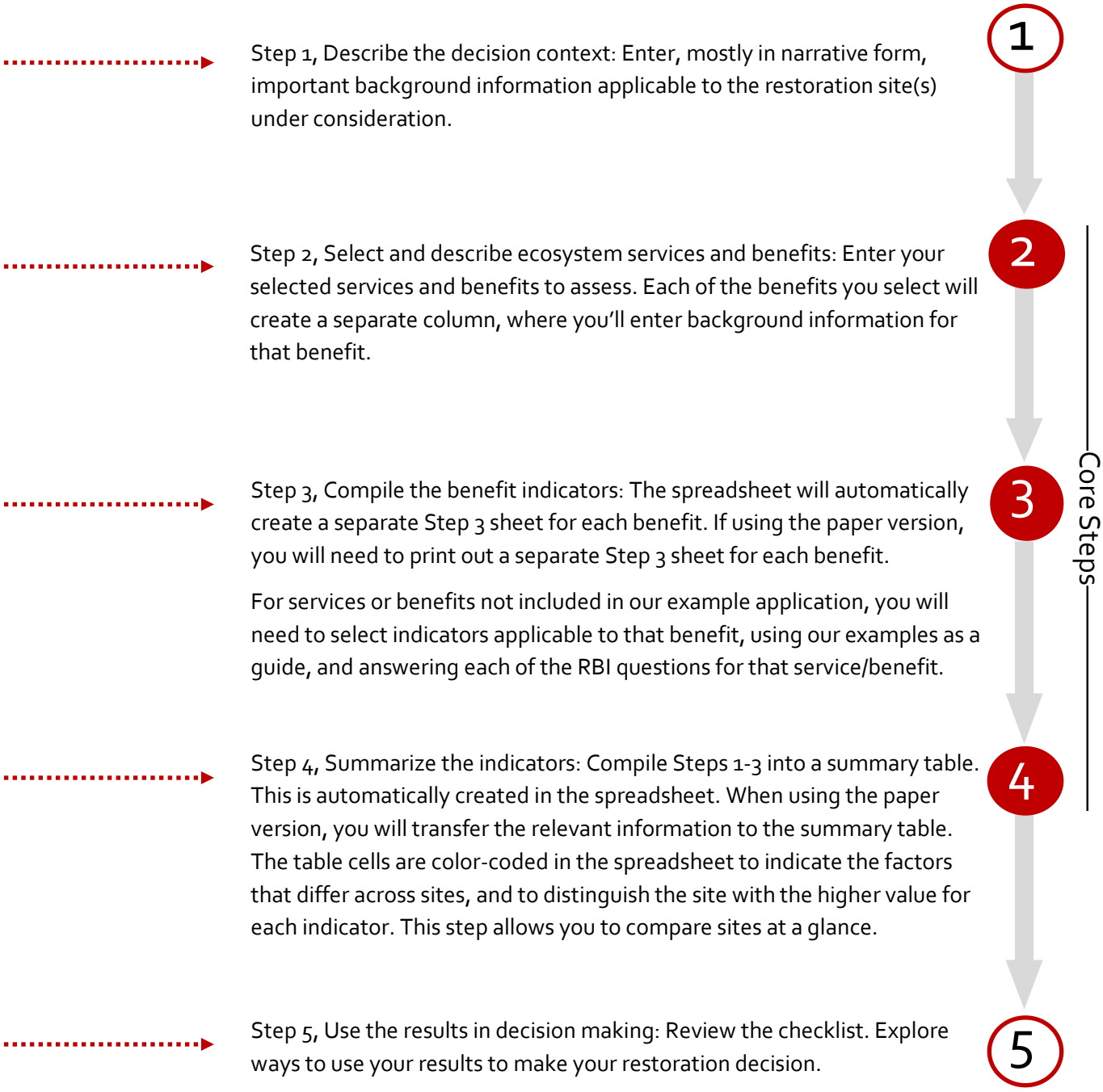
Points out places in the RBI to engage stakeholders and the public.

Points to helpful tidbits that complement the guide text.

The Checklist: How to use it

The accompanying Excel® Checklist Tool (see Appendix 1 for a printout) follows the RBI approach and provides a place to record collected information. The Checklist can either be used in Excel®, where prompts help guide the process and the information is automatically summarized; or printed from the hard copy in Appendix 1 and filled out on paper to compile your information.

On the "Steps in Action" pages the words "**In the checklist, …**" highlight information relevant to the checklist and describe what to enter to answer each question. These are based on our example comparison of two sites in the Woonasquatucket River Watershed, RI., for a selected set of services. The full Checklist for our example is presented in Appendix 2.



Step 1, Describe the decision context: Enter, mostly in narrative form, important background information applicable to the restoration site(s) under consideration.

Step 2, Select and describe ecosystem services and benefits: Enter your selected services and benefits to assess. Each of the benefits you select will create a separate column, where you'll enter background information for that benefit.

Step 3, Compile the benefit indicators: The spreadsheet will automatically create a separate Step 3 sheet for each benefit. If using the paper version, you will need to print out a separate Step 3 sheet for each benefit.

For services or benefits not included in our example application, you will need to select indicators applicable to that benefit, using our examples as a guide, and answering each of the RBI questions for that service/benefit.

Step 4, Summarize the indicators: Compile Steps 1-3 into a summary table. This is automatically created in the spreadsheet. When using the paper version, you will transfer the relevant information to the summary table. The table cells are color-coded in the spreadsheet to indicate the factors that differ across sites, and to distinguish the site with the higher value for each indicator. This step allows you to compare sites at a glance.

Step 5, Use the results in decision making: Review the checklist. Explore ways to use your results to make your restoration decision.

An Example Application

Photo by: Rick McKinney

Restoring Wetlands in the Woonasquatucket River Watershed

What is the Woonasquatucket?

The Woonasquatucket (woon-AHS-kwa-tuk-it) River flows southeast through northern Rhode Island, from the town of North Smithfield into the city of Providence, the state's capital. Its name, Woonasquatucket, was given to it by local Native Americans and translates as "the place where the salt water ends" or the meeting of the river and the sea. The river is 19 miles long and its watershed covers approximately 50 square miles. The Woonasquatucket flows from mixed suburban and agricultural settings in its northern headwaters into highly urbanized neighborhoods downstream. Its watershed encompasses portions of eight municipalities, with a wide range of demographics.

A designated American Heritage River, the Woonasquatucket has a long history of cultural and industrial development. Its waters once powered many manufacturing facilities, mills, and farmhouses, and transported a variety of goods. Development for use of the river occurred immediately adjacent to and even over the river, often destroying wetlands and filling floodplains. Today, the river is still a hot spot for human activity, in some areas serving as a prime choice for homes and communities. With urbanization trends projected to increase in the years to come, it is expected that the river's resources will be in more demand than ever before. Resource managers are looking for opportunities to restore previously neglected areas of the watershed in order to prepare for a healthier, more sustainable river tomorrow.

We present the RBI using the Woonasquatucket Watershed as an example. Throughout this Guide, we will point out aspects that are specific to the Woonasquatucket vs. those that might be generally applicable to your restoration site.

Why we chose the Woonasquatucket to demonstrate this approach

The Woonasquatucket is a living resource that many Rhode Islanders interact with on a daily basis. Its location, spanning agricultural and suburban areas to the most urbanized communities in Rhode Island, provides an opportunity to understand many facets of restoration, including issues specific to urbanizing and urban areas. The Woonasquatucket Watershed has an active community of supporters, focused around the Woonasquatucket River Watershed Council.

Several studies of the Woonasquatucket have been conducted in the past, including studies of filled wetlands and a functional assessment approach for evaluating restoration of those sites (Miller and Golet 2001, Golet et al. 2003). We chose to build upon those studies to create the RBI as a process that would more accurately capture the services and benefits people receive from the Woonasquatucket today.

As an urbanizing watershed, the Woonasquatucket illustrates important issues related to the valuation of ecological quality and societal benefits, including:

- *Deciding whether to restore a site based on its ecological benefits or the benefits people receive from it.* Small urban sites with relatively low ecological benefits can provide large social benefits, though they don't typically rank well under most existing ranking criteria.
- *Deciding which services are most relevant.* Some services, such as flood water regulation, can be especially important in urban areas.

How understanding the Woonasquatucket can help you

Even though the Woonasquatucket may not be your watershed or potential restoration site, its diverse land uses—ranging from suburban to highly urban—makes it a case that can be applicable to many watersheds, particularly in the northeastern U.S. Its range makes it an ideal example of the variety of stressors that urban watersheds are facing today. We also present insights regarding public and stakeholder views of barriers to and opportunities for restoration in Rhode Island, based on interviews with 27 resource managers who conduct restoration projects, giving invaluable insight into the public engagement process. Understanding the Woonasquatucket as we present it in this guide—primarily as an example application for the RBI—will leave you with a greater understanding of and appreciation for your watershed, and with tools that can assist you in your restoration decisions.

Applying the RBI in Your Location

Now that you've read about the Woonasquatucket, think about all the ways your watershed is special to you. What has it meant to your community? What does it mean now? What are some of the points of contention regarding management and restoration? Our examples apply to the Woonasquatucket, but they may also apply to your location. As you walk through the steps and review the "Steps in Action" pages that feature the Woonasquatucket, you can adjust your responses to the guided questionnaire and checklist tool to fit the circumstances of your restoration decision. Though the examples in this guide are from the Woonasquatucket, each step of the RBI can be applied to any site you choose.

Public Engagement is Essential!

Engage the public & stakeholders for project success

Community members can help prioritize, implement, and monitor projects, and their involvement can promote broad-based support for restoration efforts. For better ecological and social outcomes, find creative ways to involve stakeholders early and often in restoration projects (Drusckhe and Hychka, 2015).

Engage the public & stakeholders by:

- √ **Finding ways for community members to contribute through workdays or community celebrations.**
- √ **Contacting local interest groups and asking them to nominate specific restoration sites.**
- √ **Enlisting neighbors in monitoring efforts at restoration sites.**
- √ **Asking to attend existing community meetings and listening to what stakeholders say about the issues that matter to them.**
- √ **Hitting the pavement. Spending time in your target community, talking with residents and neighbors and listening to their interests and concerns.**
- √ **Hosting public meetings that feature knowledgeable and approachable speakers who can explain restoration in plain language. Making sure there are chances for people to give meaningful feedback.**
- √ **Conducting formal interviews and focus groups to learn about resident interests and concerns.**
- √ **Consulting with resource managers who have on-the-ground experience working in particular communities.**
- √ **Working with local media outlets to get the word out about projects.**
- √ **Engaging schools and local community groups in adopting particular sites.**

Stakeholders can assist restoration projects by helping you:

- √ **Choose the right project,** by working with the people who know the area, its history, its major players, and the political climate.
- √ **Avoid delays** in your project, because community members can help to minimize surprising concerns. Early efforts to reach out to local communities can mean that neighbors will help rather than obstruct a project.
- √ **Get funding,** because funders like to know that you have talked—*and listened!*—to stakeholders.
- √ **Have a lasting positive impact,** because the people living near the project can take ownership of a project and protect the investment.
- √ **Create more public awareness** of and interest in specific restoration efforts and in restoration more widely.

Photos by: Woonasquatucket River Watershed Council (WRWC)

Photo by: Rick McKinney

The RBI step-by-step process starts here

Step 1: Describe the Decision Context

Questions addressed in this step:

- What are the objectives and geographic scope of the decision?
- Who are the affected people, and what are their important needs?
- Is a rapid assessment sufficient?

What does this step do?

This step provides the overall decision context and gathers some important initial information.

How to apply this step:

To apply this step, you may want to consider the following questions, and perhaps others, depending on your specific context.

A. What are the main objectives of the assessment/decision?

Are there specific policy objectives to consider?

Examples:

- Do you have a certain amount of money to spend, and want to select one or more restoration sites to get the greatest benefits for the money spent?
- Do you want to enhance a particular service (or services) within your watershed such as bird viewing or flood protection?
- Do funding sources specify particular goals?

Are some objectives more important than others?

Examples:

- Watershed ecological objectives come first, followed by social objectives
- Water quality objectives such as meeting a regulatory requirement come first, followed by providing co-benefits

In the checklist, enter this information in narrative form.

B. What is the geographic scope for the decision?

Is it a watershed, a municipality, a neighborhood, or a specific site?

In the checklist, enter this information in narrative form.

C. Who are the affected members of the public or stakeholder groups?

In the checklist, enter this information in narrative form.

You may want to use ArcGIS Online, Google Earth, or other tools as appropriate to compile:

- geographic placement of each site that will be assessed (latitude-longitude, maps)
- aerial or satellite photos
- census blocks including and near the site.

D. Are there important stakeholder or public needs or wants? Are there any important conflicts?

In the checklist, enter this information in narrative form.

E. Is a rapid assessment sufficient or will more detail be needed for some or all of the assessment?

In some cases, particularly where the stakes are high and it is particularly important to reduce uncertainty, it may not be appropriate to use a rapid assessment.

In the checklist, check yes or no.

F. How many sites are being evaluated?

G. How are the sites identified?

In the checklist, enter the number of sites and a name or other identifier for each site.

H. Is there any additional information important to framing the decision?

For example, there might be an important brownfield or Superfund site in the watershed; or perhaps the community just finished a major public engagement effort to redo its Master Plan. Some general categories to think about include: major political changes, recent natural disasters, and the like.

In the checklist, enter this information in narrative form.

Feasibility and potential roadblocks to implementation determine the success of any restoration project.

Factors that affect feasibility might include:

- the technical and logistical ability to accomplish restoration
- the general level of public buy-in
- site contamination
- current or potential competing uses
- issues related to private property such as permissions required to access the property

You, the practitioner, will have the most awareness of and information about issues related to feasibility.

Step 1 in Action—Describe the Decision Context

The **"in action"** pages provide examples of how the RBI Approach can be applied to a real restoration decision, using indicators developed for our example location, the Woonasquatucket watershed. We have created an imaginary scenario that compares two actual Woonasquatucket sites, in order to walk you through the process.

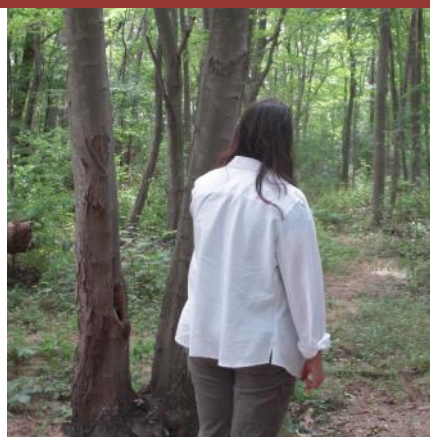


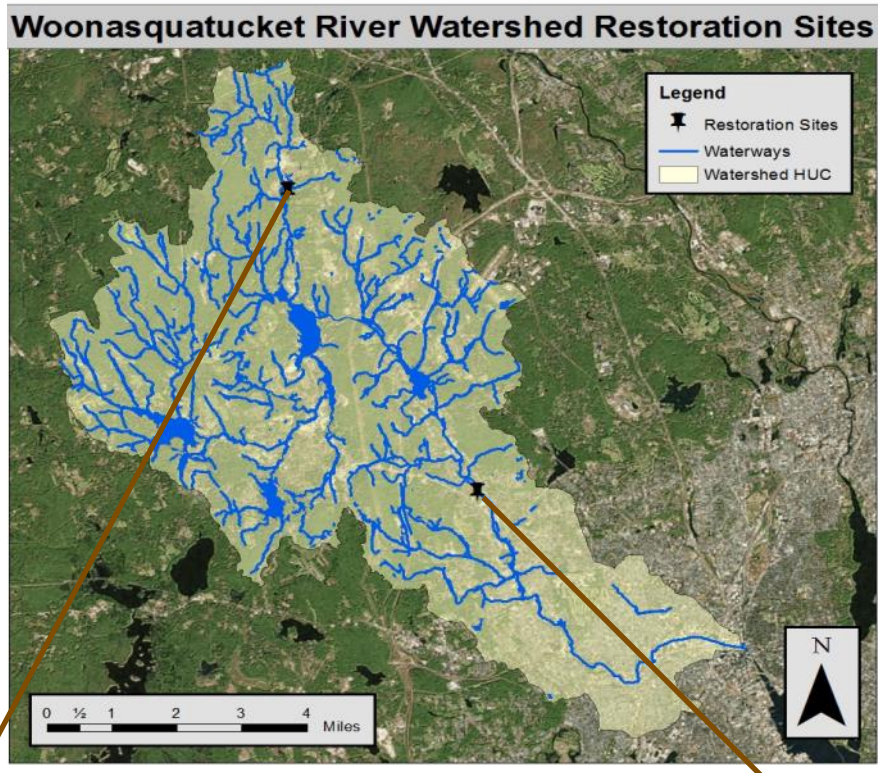
Photo by: Kristen Hychka

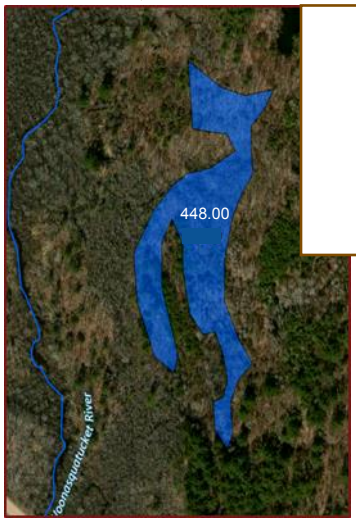
Suppose that Maria is the manager of a watershed group that has been given a restoration grant, and needs to select one or more restoration sites to get the best return for the money spent. Previous work in the watershed provided a list of former wetlands sites that have been filled and could be restored to functioning wetlands. Local community groups have nominated two sites, which Maria's group will evaluate.

Guiding questions → **Maria's response**

Step	Question/Category	User Entries
1	**Describe the decision context for Woonasquatucket Example**	
1.A	**What are the main objectives of the assessment?**	We have a budget of $50,000 to spend on restoration in our watershed. We want to know which site or sites we can restore to provide the greatest benefits within this budget.
	Are some objectives more important than others, or are there additional important objectives? If so, specify.	We want to balance community benefits with ecological benefits.
1.B	**What is the geographic scope for the decision?**	The overall scope is the Woonasquatucket River Watershed. We have selected 2 sites to evaluate; the sites were proposed by local community groups.
1.C	**Who are the affected members of the public or stakeholder groups?**	In general, the people who live and work in the watershed. The communities near each of the sites are likely to be especially interested in their nearby site.
1.D	**Are there important stakeholder or public needs or wants? Are there any conflicting needs/wants?**	None have been identified upfront, but we will include the affected and interested people throughout the assessment and decision process.
1.E	**Is a rapid assessment sufficient?**	◉ Yes ○ No
1.F	**Number of sites**	2
1.G	**Site names or identifiers**	Site 1: Greystone Site 2: #448
1.H	**Is there any additional information important to framing the decision?**	We will evaluate feasibility of restoring each site and consider that in making the decision.

Here, we've compiled basic information about our two sites: maps, aerial photos, site photos, and general descriptions.





Site #448:

- 3.84 acres in N. Smithfield
- privately-owned
- overall functional score: 10/10

Greystone:

- 0.54 acre in Johnston
- privately-owned
- overall functional score: 4.5/10

Step 2: Select Ecosystem Services & Describe Benefits

Questions addressed in this step:

- Which ecosystem services are most relevant to the decision?
- Which benefits of these services are important?
- What are the general characteristics of each service and its benefits?

What does this step do?

This step narrows the focus to the most relevant services, and compiles basic information about each.

How to apply this step:

A. Select ecosystem services and their benefits to assess

Some restoration sites may not provide every service, and not all services are relevant to all restoration decisions. Criteria you might use to select services include whether:

- The service is provided by a site under consideration, or you expect it to be provided when the site is restored.
- The service is one that is likely to vary in quality and benefits provided across sites, and thus can distinguish among sites.

Multiple benefits may result from each ecosystem service, and not all of these benefits are relevant to all restoration decisions. Criteria you might use to select benefits include whether:

- The benefit is relevant in your watershed.
- The benefit is relevant to specific policy or management goals.
- The benefit is important to stakeholders or the public.

Selecting services and benefits may include several components:

- Preliminary rapid assessment of functions and benefits.
- Consultation with technical experts.
- Public meetings or focus groups with interested citizens.

Page 5 lists the services included in this Guide. You may choose to address other services, and can do so by following the process described in this Guide.

B. Provide a basic description and background for each benefit

This step is a simple compilation of general information about each benefit. It is conducted for each benefit individually. *We have compiled information for 5 services and benefits in the following pages. These examples illustrate how to apply this step.*

C. Compile information on concerns or disservices

See page 20 for a discussion of disservices.

D. Note how each service interacts spatially with the people who benefit

See page 21 for characterizations of the typical spatial interactions.

Addressing Concerns and Disservices

Stakeholders may be concerned about possible adverse outcomes—called *disservices*—that can result from ecosystem restoration. Site evaluation efforts should consider these potential disservices, whether decision makers agree with community members' perceptions of disservices or not.

Photo by: Kristen Hychka

Recognizing potential or perceived disservices is a necessary early step for more effectively communicating with community members, finding creative ways to mitigate potential unwanted outcomes, assessing the likelihood of success, and moving forward on projects.

Restoration managers can rely on community leaders, public meetings, interviews, surveys, news media, and informal conversations to identify potential disservices or concerns that exist or might be perceived to exist.

Some potential disservices to consider related to urban wetland restoration are:

- Habitat for unwanted species, including mosquitoes, ticks, and rodents
- Changes to aesthetics, potential loss of a treasured view
- Loss of historic heritage
- Loss of recreational opportunities
- Safety concerns about crime in unmonitored vegetated areas
- Debris, trash, odors, or vandalism
- Possible increase in flooding
- Nuisance from construction work, including noise
- Movement of contaminated sediment
- Lowered nearby property values
- Limits on use of private or public property

Real World Example: In a city park urban buffer restoration project, adjacent residents were concerned that the new vegetation would harbor rats. From manager accounts, these fears played out—rats were using the buffer as habitat. In hindsight, the manager suggested that the neighbors' concerns about rats should have resulted in the incorporation of rodent management strategies as part of the project implementation.

Spatial Relationships Between Services and the People they Benefit

It is important to understand the relationships among the place where a service is generated, the place where people can benefit from the service, and the place where people who benefit are located. This information will help determine the area to consider when making a decision, how many people benefit, and who those people are.

There are three general categories:

1. Services and benefits occur at the same location

People travel from where they live, work, or attend school to the area where benefits occur to gain the benefit.

Example: Clean water is a service that allows for swimming, a recreational opportunity, but people must travel to the site to swim, a benefit.

2. Services flow in all directions from a site and benefits occur in the surrounding area

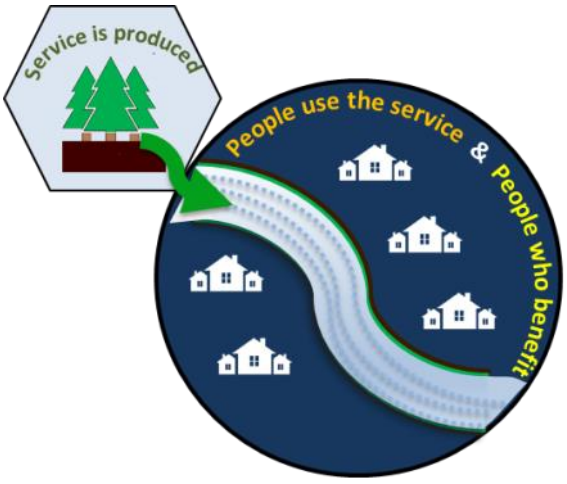
People who are in the area where benefits occur will gain a benefit.

Example: Birds, a service, are attracted to particular habitats. People around those habitats will benefit by seeing and hearing the birds.

3. Services flow in a restricted direction from a site and benefits occur in a specific area

People who are in the specific area where benefits occur will gain a benefit.

Example: A wetland retains water, decreasing the quantity of water downstream, a water regulating service. People or structures must be in the area downstream where flood waters are decreased, in order to benefit from the reduced flood risk.



Step 2 in Action—Select Ecosystem Services and Describe Benefits

A. Select ecosystem services and their benefits to assess

For our example comparison sites, we focus on: flood water regulation for reduced flood risk, scenic landscapes for scenic views, learning opportunities for environmental education, recreational opportunities for recreation, and birds for bird watching.

In the checklist, check the ecosystem services and their benefits that you are assessing.

Urban wetlands provide many ecosystem services not included in this example. For example, storm water regulation, carbon sequestration, and temperature regulation are not included in our site comparison. You can use the same assessment approach with these or other services, and add them to the checklist tool.

In the checklist, add additional services as "Other."

Ecosystem services selected may include benefits in addition to the ones we focus on here. For example, flood water regulation may result in benefits from reduced need for gray (built) infrastructure.

In the checklist, select from the suggested benefits or add additional benefits as "Other."

B. Provide a basic description and background for each benefit

C. Compile information on concerns or disservices

D. Note how each service interacts spatially with the people who benefit

Steps 2. B, 2.C, and 2.D are conducted for each benefit individually. *We have compiled information for 5 services and benefits in the following pages. These examples illustrate how to apply parts B-D of step 2.*

Sample Page from the Checklist

Step	Question/Category		
2	**Select Ecosystem Services and Describe Benefits for Woonasquatucket Example**		
2.A	**Which Ecosystem Services are most relevant to the decision?**	☑ Flood Water Regulation ☑ Scenic Landscapes ☑ Learning Opportunities ☑ Recreational Opportunities ☑ Birds ☐ Other ()	
	What Benefits of the selected services are relevant to the decision?	☑ Reduced Flood Risk ☑ Scenic Views ☑ Environmental Education ☑ Recreation ☑ Bird Watching ☐ Other ()	
2.B	**Benefit Name**	**Reduced Flood Risk**	**Scenic Views**
	Provide background information on each service and the benefits being assessed.	Wetlands retain water that would otherwise increase flooding, providing flood risk reduction benefits. We only consider reductions in flood risk to structures in the floodplain within 4 miles downstream.	Aesthetically pleasing landscapes provide observers with scenic views. We only consider views from homes or other structures.
2.C	**Provide background information on the concerns and disservices that may relate to the services and benefits being assessed.**	Water retained in wetlands may inundate areas directly surrounding the wetland or upstream, potentially causing flood damages in those areas.	Poor maintenance of a site may lead to accumulation of trash or overgrown vegetation, giving a "messy" appearance that people dislike.
2.D	**How do services and people interact geographically?**		

There will be one column specific to each selected Ecosystem Service

Step 2 in Action—Describe Benefits: *Flood Risk Reduction*

Photo by: Tim O'Connor WRWC

B. Provide a basic description and background

Wetlands can slow or retain water that would otherwise increase flood damages, providing flood risk reduction benefits.

Flood magnitudes in the Northeast have increased over time (Collins 2009; Hirsch and Ryberg 2012; Hodgkins 2010; Peterson et al. 2014; Smith et al. 2010; Villarini and Smith 2010) and are projected to continue to increase with climate change (Horton et al. 2014). Floods that occur where people live, work and play can result in illness, injury, loss of life, damaged property, destruction of culturally significant structures, and disruption of commerce and critical services.

In an urban context, where there are more people and structures at risk, flood damages are often greater than in less populated areas (Hardmeyer and Spencer 2007; Mitsch and Gosseline 2000). Urban areas also tend to have more impervious surfaces, which convey stormwater faster and do not allow it to infiltrate into the ground, resulting in higher peak flows. Stormwater may carry debris that can block stormwater infrastructure causing localized flooding or pollutants that can impair water quality in downstream water bodies (Mallin at al. 2008).

A site that retains water, especially during the peak of storm flow, removes that water from the peak flow and releases it slowly. This generally lowers water elevation in the floodplain and decreases flooding. It can also reduce reliance on stormwater infrastructure and impacts on water quality. We do not provide indicators for these additional potential benefits.

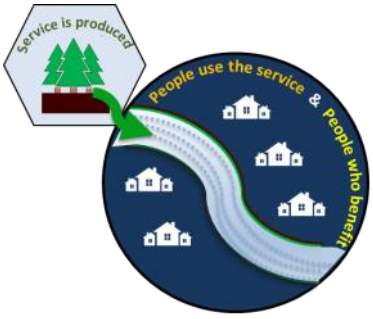
In the checklist, clarify the range of flood reduction benefits you are assessing.

For our example assessment in the Woonasquatucket, we consider reductions in flood damage to structures located in the watershed's floodplain, and do not include structures that are farther downstream or outside of existing mapped floodplains.

C. Compile information on concerns and disservices

There is a chance that water retained in wetlands might inundate areas directly surrounding the wetland or upstream, potentially causing flood damages. It is important to engage stakeholders near the restoration site to discuss this possibility. If there are concerns, experts might weigh in on the likelihood of localized flooding. If addressed early in the planning process, there may be ways to ameliorate this problem.

In the checklist, note any specifics of sites that might raise concerns about restoration increasing nearby flooding.



D. Note how the service interacts spatially with people who benefit

Water is retained at the restoration site, but people benefit from reduced flood risks in downstream areas where people and structures at risk from flooding are located (Category 3, page 21).

Step 2 in Action—Describe Benefits: *Scenic Views*

B. Provide a basic description and background

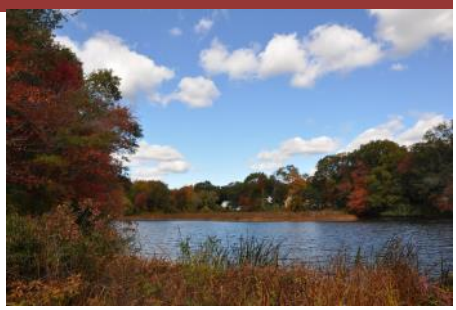


Photo by: WRWC

Scenic landscapes provide observers with aesthetically pleasing scenic view benefits. For observers to enjoy seeing a wetland, they must have an unobstructed view. Seeing a wetland does not guarantee positive scenic view benefits. It is often only one component among other features and habitats in the view, but wetlands often improve the aesthetics of a landscape.

Aesthetics are subjective, and values for views vary across people. Researchers have synthesized values for views by having people rank or rate landscapes depicted in photographs, and identifying features that correspond with high ratings (Anderson and Schroeder 1983; Dhami and Deng 2010; Dramstad et al. 2006; Gobster and Westphal 2004; Hands and Brown 2002; Kenwick et al. 2009). Consistently, views with open water rank higher than those without, and there is evidence that the presence of water increases the value of a view even when the water itself is not visible (Dramstad et al. 2006).

The value of wetlands as components of scenic landscapes has also been demonstrated in models comparing sales of properties with or without views of wetlands (Sander and Polasky 2009; Walls 2013). Nearby wetlands correlate with higher sales prices in most of these models, but it is difficult to separate how much of that price increase is the result of views rather than other wetland benefits.

People who are not property owners also benefit from scenic views by viewing landscapes during daily activities, such as driving. Scenic views may also add to the quality or value of other benefits, such as recreational benefits enhanced by scenic views along a hiking trail.

In an urban context, buildings and other development will often obstruct or detract from the total scenic quality of the landscape. Because wetlands in this context contrast with the built environment, they may have more value here than in more natural landscapes.

In the checklist, note limitations and clarifications on the scope of scenic view benefits you are assessing.

For our example in the Woonasquatucket, we only include scenic views from homes or other structures.

C. Compile information on concerns and disservices

Views of wetlands are typically less offensive than the urban features and characteristics of landscapes associated with visual blight, such as highways and transmission lines (Bagstad et al. 2011). However, poor maintenance of wetlands can lead to accumulation of trash or weedy vegetation that result in a messy appearance that people dislike (Anderson and Schroeder 1983; Hands and Brown 2002; Kenwick et al. 2009; Nassauer 2004; Ode et al. 2008), or may raise concerns about safety (Gobster and Westphal 2004).

In the checklist, note any specifics of the site that might make it difficult to maintain, or that might raise concerns among the public.

D. Note how the service interacts spatially with people who benefit

Aesthetically pleasing landscapes produce scenic view benefits that flow via line of sight from that landscape to people who view them (Category 2, page 21). Terrain, buildings, and trees between the landscape and the viewer can obstruct scenic view benefits.

Step 2 in Action—Describe Benefits: *Environmental Education*

B. Provide a basic description and background

Photo by: WRWC
Fourth graders release trout that they raised as a class into the Woonasquatucket River RI.

Natural areas provide learning opportunities that lead to educational benefits, and environmental education is one of the important ways that ecosystems support human well-being. In one study, 54 % of respondents considered environmental education to be important to human well-being. It ranked third in importance, behind water quality and conserving biodiversity (Martin-Lopez et al. 2014).

In an urban context, where there may be fewer opportunities to experience nature, children often lack the relationship with nature that children in rural areas have (UK NEA 2011). While urban students may take day trips to more pristine habitats with educational facilities to accommodate structured learning, this can be costly and reduce time spent at school. Holzinger et al. (2014) examined two years of school and nursery trips to a park with outdoor education programs in Birmingham, UK. The average travel time, not accounting for traffic, for these trips was 51 minutes, with an extra cost of about $28 per student over the same time spent at school. While urban natural areas are typically not as pristine or may not have equivalent facilities, they are more accessible to urban students. Even where resources for field trips are available, students can visit sites closer to schools more frequently, allowing for better integration into the curriculum (Lougher 2004).

Wetlands are important ecosystems for environmental education because they support unique aquatic and semi-aquatic wildlife not found in dry habitats. Wetland restoration sites near educational facilities can also provide unique educational opportunities during the restoration process.

In the checklist, note limitations and clarifications on the scope of educational benefits you are assessing. This includes clarifying how you are defining environmental education.

For our example assessment in the Woonasquatucket, we chose only to include educational visits of less than a half day, targeting shorter, less resource-intensive trips rather than daylong field trips.

C. Compile information on concerns and disservices

Although few people would perceive sites devoted to or offering environmental education as negative, there could be concerns about safety at the site or exposure to insects or allergens during learning activities.

In the checklist, note any specifics of sites that might raise concerns about safety or exposure.

D. Note how the service interacts spatially with people who benefit

Environmental Education benefits are provided at a particular site, and people must travel to the site to receive benefits (Category 1, page 21). This requires the site to be on public land or, if on private land, for access to be permitted.

Step 2 in Action—Describe Benefits: *Recreation*

B. Provide a basic description and background

Photo by: WRWC

People use wetlands and other green spaces for many activities that lead to recreational benefits, and recreation is one of the main ways people interact with green spaces (Riechers et al. 2016). People recognize green spaces as important to human well-being, and have even cited lack of public green space as a reason they moved out of cities (Tratsaert 1998).

When assessing recreational benefits, it is essential that you define the scope of activities you are including. Recreational benefits encompass a variety of activities, each having specific requirements and user preferences. Recreational benefits often overlap with other benefits (Church et al. 2011). For example, increased aesthetic views along a hiking trail would increase the value of that trail's recreational benefits (Loomis and Paterson 2014). The exercise received while hiking provides human health benefits (Bassuk and Manson 2005; Bedimo-Rung et al. 2005). The hike might even result in educational benefits.

Several types of recreational activities are more limited in an urban context; some because the often smaller size of urban wetlands and green spaces is prohibitive and some because lower water quality or other environmental issues may lead to restrictions on uses. Urban wetlands are also unlikely to be unique or high quality enough to attract people from beyond the immediate area.

In the checklist, specify which specific recreational activities you want to assess and any restrictions that could limit recreational benefits.

For our example assessment in the Woonasquatucket, we only consider everyday outdoor recreation. We do not include activities that require additional facilities or infrastructure. We do not include activities that would attract participants from long distances but instead focus on the shorter duration (half day or less) recreational activities that occur more frequently. For an example of how assessing specific types of recreation may differ from this assessment, we have also developed separate benefit indicators for bird watching.

C. Compile information on concerns and disservices

Many of the disservices people associate with recreational sites have to do with user conflicts, which may arise when recreationists have different preferences (Gobster 2001; Jacob and Schreyer 1980). For example, a cyclist may prefer a straight paved trail whereas a recreational walker may prefer a winding mowed or gravel path. User conflicts may also arise due to congestion at a recreation site (Gobster 1995; Kuss et al. 1990). Noise and traffic congestion around the recreation site or trash left behind by users may be disruptive to local residents.

Because different users can have different visions for what a recreational space should include, it is important to engage stakeholders early on as part of the planning process. If addressed early in the planning process, there may be ways to ameliorate disservices such as noise or traffic congestion.

In the checklist, note specific concerns about recreation or disservices that may result.

D. Note how the service interacts spatially with people who benefit

Recreational opportunities become recreational benefits when people recreate there. For people to benefit they must go to the site where the recreational opportunities are produced (Category 1, page 21).

Step 2 in Action—Describe Benefits: *Bird Watching*

B. Provide a basic description and background

Photo by: USFWS National Data Library

An element of recreation is connecting with nature by experiencing or viewing wildlife. Birds are frequent subjects of wildlife viewing because of their high visibility. Urban areas often lack the large and pristine habitats that certain species of birds require (Marzluff et al. 2011), but bird species that can tolerate or adapt to urban environments can be drawn to neighborhoods near parks and green spaces that provide appropriate habitat for nesting or foraging (Barbosa de Toledo et al. 2012; Fontana et al. 2011; McKinney and Nightingale 2014). Although these species are not likely to attract more serious birders from other locations, they can positively affect the attitudes and well-being of local urban residents (Belaire et al. 2015; Bjerke and Ostdahl 2004).

In the checklist, note limitations and clarifications on the scope of bird watching you are assessing. This includes which wetland-associated bird species in your study area may be the subjects of bird watching. This also includes how you are defining bird watching since it may overlap with other services such as recreation.

For our example assessment in the Woonasquatucket, we included urban birds in the Northeastern United States (Table 1 in the Appendix). We defined bird watching benefits as those of local residents, excluding serious birders who might travel from other areas to see birds.

C. Compile information on concerns and disservices

People in urban areas have expressed concerns about, and even negative attitudes towards, certain species of birds. Messy droppings and nesting in houses are some of the disservices people associate with what they consider to be pest bird species (these include the common grackle, house sparrow, blue jay, and European starling; Belaire et al. 2015). However, when compared to other wildlife pests, at worst people had neutral rather than negative perceptions of birds (Bjerke and Ostdahl 2004).

Because people may have mixed perceptions of birds, if concerns emerge during the public engagement process, it will be important to examine the impact of the proposed restoration on particular species of concern.

In the checklist, note any specific concerns about birds or bird species that are associated with disservices in your watershed.

D. Note how the service interacts spatially with people who benefit

Bird watching benefits will be greatest at the roosting or nesting location and flow outward from there in all directions (Category 2, page 21) based on the distance each bird species travels. The area where people may benefit may be somewhat larger than the birds' travel distances, because people can view birds from a distance. The benefits area will be available to people within this visual range of birds, but people farther away will be able to benefit if they are willing to travel. It is common for avid birders to travel long distances to sites specifically to see birds. For example, 25 % of birders in Rhode Island come from out of state (USFWS 2001). However, unless there are iconic species or uncommon migrating species, it is not likely that birders will travel to view the birds found in small urban wetland areas.

A Note on Data Quality

The quality of the output from this tool is only as good as the information you put into it. While there is a great deal of freely available information, there's no guarantee of good quality, so be sure to check the reliability of sources for any information you use.

In Appendix 4, we've listed the data sets that we used for our examples, to give you an idea of appropriate sources of data. Where possible and relevant, we suggest nationally available datasets.

Photo by: Rick McKinney

Step 3: Compile Benefit Indicators

Questions addressed in this step:

- Are people able to receive benefits?
- Who receives benefits?
- How does the value of each benefit compare across sites?
- What are the social equity implications?
- How reliable are benefits over time?

What does this step do?

This step is the core of the approach. In this step, you will compile information to assess the level of benefits each site may provide to people.

How to apply this step:

As you apply this step, you will answer a series of questions to develop a set of indicators for the benefits you chose to assess in Step 2. Some questions are optional, as noted. These optional questions can fine-tune the assessment, but may be difficult to answer with available data.

There are five categories of questions:

1) Can people benefit from the ecosystem service?
2) How many people benefit?
3) How much are people likely to benefit?
4) What are the social equity implications?
5) How reliable are the benefits expected to be over time?

To answer the first three questions, each benefit is evaluated separately. Questions 4 and 5 may be addressed at the site level, but in some cases the comparison might be improved by also considering factors specific to individual benefits.

We first describe each of these questions and the general types of indicators that answer them. We then present specific rapid assessment indicators for each benefit included in our example application.

Question 1: Can people benefit from the ecosystem service?

Answering this question involves three sub-questions that look at the interactions between people who benefit and the site that provides those benefits (or in economics terms, the intersection of supply and demand). Without these factors, it will not be possible for people to benefit from the ecosystem services provided by a site or ecosystem.

Question 1 is for initial screening and each of its three sub-questions can be answered as "Yes" or "No." Answering these sub-questions does not require detailed assessment or data – it can be completed using best professional judgment of the group conducting the assessment, possibly with input from stakeholders. If the answer to any of the sub-questions is "No," people are not able to benefit from the service and Step 3 of the assessment is complete for that benefit.

The 3 sub-questions are:

A. Is there evidence of demand for the service?

First, it is important to understand whether people want or need the service. This involves identifying the relevant benefits area and determining whether people within that area want or need the service.

Examples: For people to benefit from nature education, there may need to be a school within walking distance of the site; or for people to benefit from reduced flood risk, there must be valued structures or infrastructure in the downstream flood zone.

B. Are any necessary thresholds of quality or quantity met?

Second, it is important to know if the site functions well enough to provide adequate services. This involves identifying the minimum level of ecosystem functioning required (a threshold) to provide the required quantity of the service at the required quality.

Example: For valued birds to use a site, the site may need to be a minimum size and have specific types of vegetation.

C. Is specific infrastructure or other "complementary input" needed and, if yes, is it available?

Third, some services require additional inputs before people can benefit. These inputs, such as infrastructure or policies that enable use of a site, are considered "required complements."

If such complementary inputs are required, are they available or will they be created as part of the restoration?

Example: For recreational hiking, users require a hiking trail.

If all of these 3 questions are answered "Yes," then people are able to benefit.
Continue to the next question.

If the answer to one or more of these 3 questions is "No" then people are not able to benefit in this way from this site.

Continue to the next benefit.

Question 2: How many people benefit?

Answering this question involves defining the area where people may benefit, and counting the people within that area who may benefit. It may be done with varying levels of rigor, from a rough estimate to mapping the specific people who may benefit.

The simplest approach is to select an area around each site, based on the typical distance from the site where people are likely to benefit. Quantify the number of people who benefit using population estimates or by counting homes within this area.

It is also possible to group people who may benefit by their distance from the site, based on the assumption that those farther away will generally have lower values for the service. Using this approach, count people or homes within each grouping by distance, giving those farther away lower weight. The most complex approach is to use spatial models and possibly additional information about users or potential users (which might be gathered through talking with the public or stakeholder groups).

Example: Studies show that urban recreation areas are mostly used by people within walking distance, and that a reasonable distance to walk for children and older adults is 400 meters (around 1/4 mile). This information can be used to estimate how many people are within walking distance of a location.

Question 3: How much are people likely to benefit?

Answering this question adds details that help indicate how much people value the benefits they receive, based on several factors.

A. Quality of the service

This evaluates the quality of a service, assuming that higher quality services have greater value. Because service quality depends on how well the system functions, this step often will involve some type of functional assessment. In the simplest case, you might use the scores from a rapid functional assessment such as Miller and Golet (2001) to provide an indicator of quality. Alternatively, you might use quality indicators specific to the service and benefit and related to people's preferences.

> *Example:* When comparing the scenic quality of two locations, you might consider factors like the presence of open water, which people often say adds to scenic beauty; or presence of industrial buildings, which detract from scenic beauty.

B. Substitutes for the service and scarcity of the service

This evaluates the availability and quality of substitutes for the service (either other sites nearby that provide the same service or technological substitutes for a service), assuming that fewer substitutes and/or lower quality substitutes lead to greater value. Generally, the number and quality of substitutes provides a good measure of the service's scarcity. However, for some services, additional factors related to its supply factor into the evaluation of scarcity. In general, the more scarce something is, the higher its value.

> *Example:* Other nearby wetlands might provide natural substitutes for the flood risk reduction services of a site being evaluated; levees, dams, or storm sewers might provide technological substitutes.

C. Quality of complements

This evaluates levels of quality of things that complement the service, assuming that higher quality complements lead to greater value. This step is only important for services that depend on complementary factors in order for people to benefit. While complements are very important for some services, notably recreation, for others they are not needed, although their presence can lead to higher value. *This is an optional indicator.*

> *Example:* A handicap-accessible entrance can increase benefits from a recreational or educational site. A higher quality boat launch area can increase boating benefits; or the availability of a viewing platform can increase bird watching benefits.

D. Strength of people's preferences

This evaluates how much people care about or value the service, assuming that stronger preferences lead to greater value. In some cases, it might be useful to group people by strength of preferences or types of preferences, in order to better evaluate tradeoffs. It might be possible to learn about how strongly people prefer a service in a particular location, either through their demonstrated interest (for example, by participating in public programs or meetings or writing letters to the editor), or by talking with the public. This step may also look at people's willingness or ability to substitute for the service (their adaptability), by evaluating aspects such as how necessary a service and its benefits are to the people who benefit. *This is an optional indicator.*

> *Example:* People with limited access to transportation will rely more heavily on sites within walking distance, and be less able to substitute sites that are beyond walking distance. Thus, they will prefer sites within their neighborhood.

Question 4: What are the social equity implications?

This question assesses issues such as equity and fairness or whether particularly vulnerable groups might benefit from the service. It is generally evaluated at the site level, rather than for each service individually, although there could be service- or benefit-specific aspects to consider. See the additional information page on this topic (page 33) for more information.

Question 5: How reliable is the service expected to be over time?

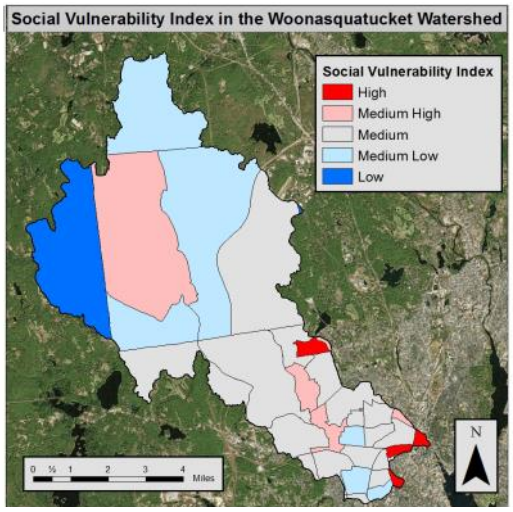
This question assesses how likely it is that the service will continue to be provided over the longer term. It is generally evaluated at the site level, rather than for each service individually, although there could be service- or benefit-specific aspects to consider. A restored site may be at risk of being degraded over time if it is subject to different types of pressures or stressors. This step includes indicators of factors that affect the probability that a site will continue to function at a level that can provide the service over time. See the additional information page on this topic (page 34) for more information.

> *Example:* One site might be located in an area with strong development pressure, while another might be surrounded by protected land. The second site is likely to function more reliably over time.

Social Equity

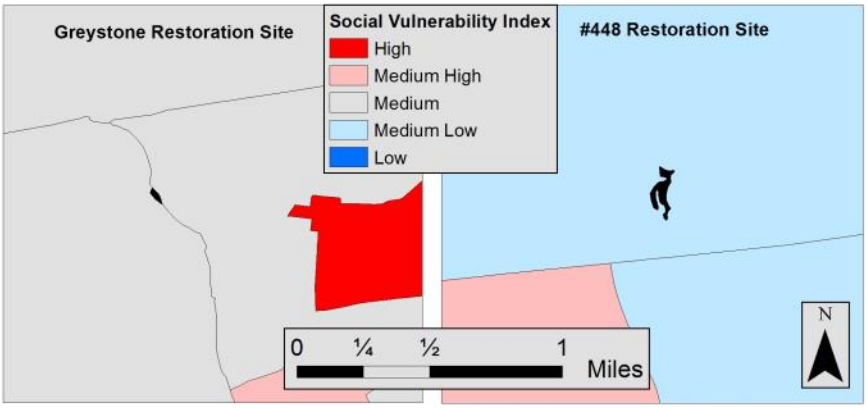
The social equity assessment looks more closely at the groups who benefit, to assess concerns related to environmental justice and potential effects on particularly vulnerable populations. Because people prefer to live in neighborhoods with more environmental amenities, housing prices tend to be higher in those neighborhoods, which can limit some people's access to environmental amenities. Also, neighborhoods with fewer natural areas and more impervious surfaces tend to be more at risk for flooding and other negative environmental impacts. People living in these neighborhoods may have fewer resources for dealing with such events.

An assessment of social equity would consider the groups of people who benefit from restoration. For a general assessment of social equity , conduct a single assessment for each site, evaluating people within the greatest distance for estimating who may benefit (which, for our example, is 2.5 miles for flood risk reduction). A more detailed assessment can look at individual benefit distances. However, since the objective is to compare across sites, using populations within a 2.5 mile radius will most likely be sufficient.



Map of Social Vulnerability Index (SoVI) across the Woonasquatucket River Watershed.

One method for assessing social equity is the Social Vulnerability Index (SoVI; Cutter 2003), which combines a set of statistically-relevant demographic variables summarizing information on race, class, wealth, age, ethnicity, and other factors into an index (see http://webra.cas.sc.edu/hvri/products/sovi.aspx for more information). It is intended to indicate the capacity for preparedness and response to environmental hazards, though the same demographics are likely to indicate Environmental Justice concerns. The SoVI is available at the county level for the entire United States, and there is a SoVI mapper by census tract at http://svi.cdc.gov/map.aspx.



Maps of the SoVI in the area surrounding each of our example sites.

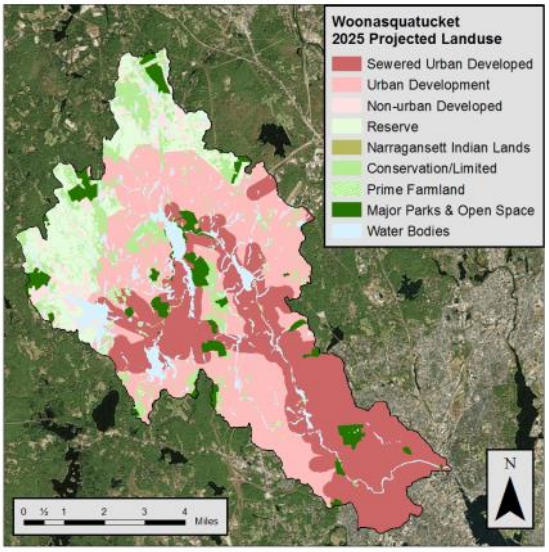
For a more detailed assessment…
For a more detailed comparison of specific benefits, you may want to include specific stakeholder concerns and local knowledge for the areas of interest.

Reliability of the Service

How likely is it that a site will continue to provide services into the future?

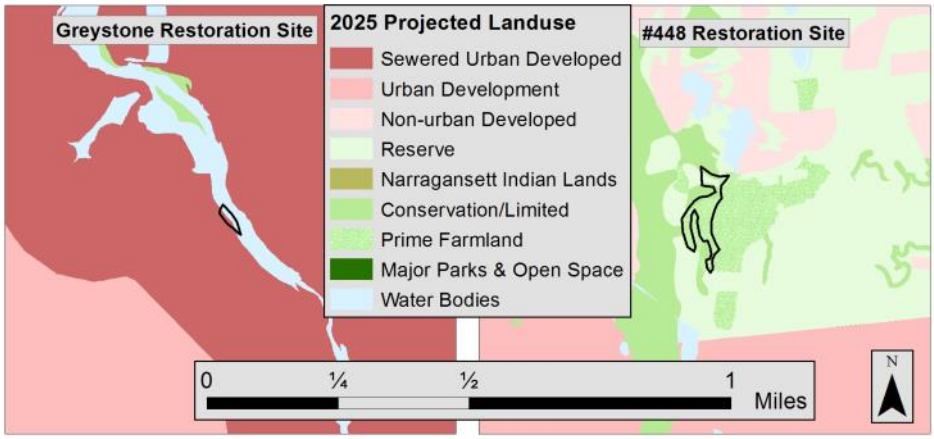
It is possible that stressors such as development near or at a site will lead to detrimental changes in the future, which could cause functioning at the site to fall below thresholds where valued services are produced.

In general, a site in an area with high development pressure is likely to have lower reliability. If this assumption holds, the level of projected development in the vicinity of the site can serve as an indicator of lower reliability; and protected land surrounding a site can serve as an indicator of higher reliability.



RI projected land use in 2025

For our examples, we used Rhode Island Statewide Planning's projected development for 2025 to compile reliability indicators. We selected the area of the site plus a 500-foot buffer, and calculated the percent of this total area classified as either protected or limited development. This included the land use categories "conservation/limited," "major parks and open space," "reserve," and "water bodies." A higher percent of nearby limited development indicates greater reliability.



Maps showing projected land use in 2025 around our example sites.

For a more detailed assessment…

Development pressure is just one possible indicator of reliability, and applies to the entire site. Other service-specific indicators may be also be chosen. Examples of reliability indicators specific to flood or storm water regulation are percent imperviousness and runoff curve number (a parameter used to predict runoff or infiltration) (Bousquin et al. 2015). Higher values of these measures would indicate lower reliability. A more detailed stressor assessment based on local conditions in the surrounding area may be warranted, and may be evaluated using modeling and expert judgment of potential threats to a site.

Step 3 in Action—Compile Benefit Indicators: *Flood Risk Reduction*

Question 1: Can people benefit from the ecosystem service?

Photo by: Tim O'Connor WRWC

For people to benefit from floodwater regulation due to restoration, people must be in the floodplain downstream of the site and currently at risk of flooding. For a restored site to provide floodwater regulation, it must be able to retain or slow runoff. Complementary inputs are not required for people to benefit from floodwater regulation.

A. Is there evidence of demand for the service?

There is demand for flood risk reduction benefits if there is existing flood risk to assets in the downstream floodplain (Bagstad 2013; Boyd and Wainger 2003). For initial screening, confirmation that flooding occurs downstream of the site is adequate.

In the checklist, mark yes if flooding has occurred or if there is a flood zone downstream of the restoration site.

For our example application in the Woonasquatucket, we found, based on newspaper reports, that there was a history of flooding in the watershed. This information was readily available because of large floods that occurred in 2010.

B. Are any necessary thresholds of quality or quantity met?

A wetland must meet certain criteria to perform its function of retaining or slowing a given volume of water. First, the runoff water that would otherwise go downstream must be able to flow into the wetland (Boyd and Wainger 2002). Second, the wetland must be able to retain enough of a volume for long enough to affect the maximum flood depth downstream. The soil infiltration, storage capacity and vegetation in the wetland will all influence this function (Chan 2006; Layke 2009; Nedkov 2012).

In the checklist, mark yes if you expect the site to be able to retain water that would otherwise flow into the floodplain downstream. You may use an existing functional assessment tool to evaluate this.

For our example application in the Woonasquatucket, we used results from a functional assessment (Miller and Golet 2001) to evaluate this.

C. Is specific infrastructure or other "complementary input" needed and, if yes, is it available?

No other inputs are necessary for people to receive flood risk reduction benefits, so this question is not relevant.

If questions A and B are answered "yes," then people are able to benefit. Continue to the next question.

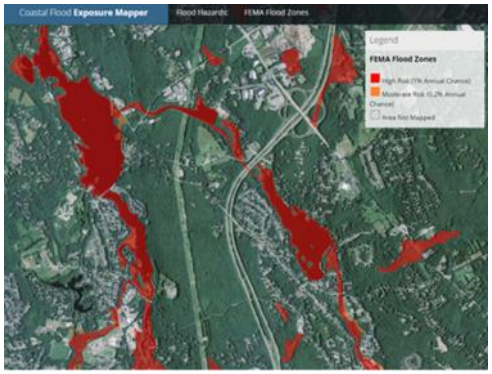
If not, continue to the next benefit.

Question 2: How many people benefit?

For the purpose of developing indicators, we assume that people who benefit must be in the downstream floodplain and must experience some level of flood risk. Defining the floodplain can be difficult without previous flood modeling or assessments. The Federal Emergency Management Agency (FEMA) maps flood risks for most of the United States — usually the 100 and 500 year flood zones— under the National Flood Insurance Program (NFIP). Many previous studies have used these flood risk maps to identify at-risk assets in the floodplain (Bagstad et al. 2011; Boyd and Wainger 2002; Chan 2006; Daniel et al. 2009).

For people to receive flood risk reduction benefits, the wetland providing the service must be upstream of structures in a floodplain, yet close enough to effectively reduce flooding. Previous assessments have used a distance of 5 miles downstream of a wetland to delineate areas where people may benefit (Boyd and Wainger 2003; Miller and Golet 2001). Our in-depth flood modeling analysis in the Woonasquatucket watershed found that a conservative distance for defining flood risk reduction benefits is 2.5 miles, based on the average distance for a set of restorations and storm events evaluated. For larger restorations and smaller storm events, the average distance increases to 4.6 miles (Bousquin et al. 2015). Therefore, we suggest using a distance of 2.5 miles to estimate the most likely benefits area in the Woonasquatucket Watershed and similar settings.

There are several ways to quantify the number of people or economically valuable assets located within the downstream benefits area. Land use and land cover maps can identify developed land at risk (Bagstad et al. 2014; He et al. 2015). Spatial datasets or aerial imagery can identify individual structures or public infrastructure (such as highways and railways) at risk (Bagstad et al. 2011). Census data and maps of population density can identify the population at risk (Brander et al. 2010; Ghermandi et al. 2010).

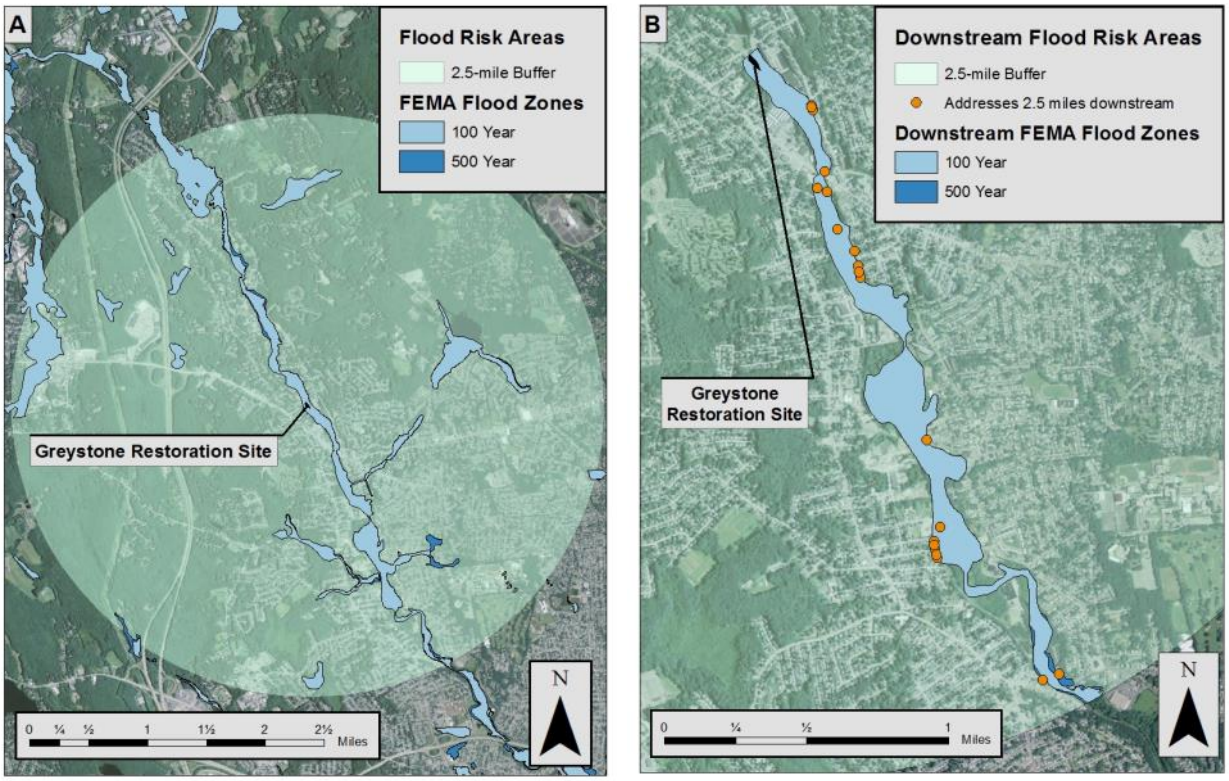


Example of a map produced using NOAA's Coastal Flood Exposure Mapper

The National Oceanographic and Atmospheric Administration's (NOAA) Coastal Flood Exposure mapper (NOAA 2015) allows users to view FEMA flood zones over base map imagery for some parts of the country. Although this mapper allows users to do a cursory exploration of assets in the flood zones, where updated FEMA flood risk maps and imagery are available they may provide better estimates of how many people benefit.

In the checklist, record the number of people or structures in FEMA flood zones within 2.5 miles downstream of the restoration site, using either address, parcel or population data.

For our example application in the Woonasquatucket, the maps below show the process followed for the Greystone restoration site. First, we used the FEMA flood zones to identify areas with flood risk in the watershed (blue-shaded areas on the maps). Next, we limited the areas with flood risk to those that are also within 2.5 miles (green circle on Map A) and downstream of the restoration site (Map B). Restoration of the site may reduce flood risks within this downstream area. Structures within this area that may be protected are shown in orange, and can be used to estimate the number of people who benefit.



Example application to the Greystone restoration site. Map A shows the FEMA flood zones (blue) and areas within 2.5 miles of the restoration site (green). Map B shows the same datasets, but limits the flood zones (blue) to those within 2.5 miles downstream of the site. Addresses (orange) within these downstream flood zones may receive reduced flood risk benefits.

For a more detailed assessment…

There are two risk zones identified in FEMA flood maps, 500-year (.2 % chance of occurring in any one year) and 100-year (1 % chance of occurring in any one year). You might separately assess these two zones, which helps to quantify the circumstances (i.e. storm size) where people may receive benefits. People or structures in the 500 year flood zone are at lower risk and likely benefit less.

Most of the people and structures who will benefit are within 2.5 miles downstream of the restoration site, but under certain circumstances there may be people and structures farther downstream who benefit to a smaller degree. You may separately count the affected number of people within 2.5 to 5 miles downstream of the restoration site. Those identified in this second distance band benefit less than those identified within 2.5 miles downstream of the site.

You may also evaluate whether there are particularly important assets protected by the site. This could include important infrastructure such as utility stations or emergency response infrastructure, or irreplaceable structures of cultural significance (Boyd and Wainger 2002; Boyd and Wainger 2003). The assessment may already identify these types of structures as potentially benefitting, but further note of their importance could assist in decision-making.

Infrastructure other than buildings, such as roads, bridges and especially evacuation routes, are prone to flooding as well. These types of infrastructure can be identified using the same flood maps and downstream distances (Boyd and Wainger 2002; Boyd and Wainger 2003). However, you should consider their elevations to determine whether they are above the average flood depth.

Question 3: How much are people likely to benefit?

A. Quality of the service

As the quality of flood water regulation services from a restoration site increase, flood risk reduction benefits increase as well. The more water a site detains or slows and desynchronizes from the peak flow, the greater the reduction in flood volume or depth during a storm (Bousquin et al. 2015; Kousky et al. 2013).

As wetland size increases, its retention capacity and therefore flood water regulation service quality typically increases (He et al. 2015). This is not likely to be a linear relationship; capacity per acre is likely to decrease with size. Restrictions at the wetland outflow can also increase retention or slow water leaving the wetland, increasing the volume of water removed from the peak flow.

In the checklist, note the size of the restoration site and indicate (yes/no) if there are features such as outflow restrictions that may increase the site's retention volume.

For our example application in the Woonasquatucket, we measured the size of each restoration site and determined presence of enhancing features using results of the previously performed functional assessment (Miller and Golet, 2001).

B. Substitutes for the service and scarcity of the service

Other wetlands in the vicinity of a wetland restoration site may provide substitute sources of flood risk reduction benefits. Dams, levees, and other types of gray infrastructure can also reduce flood risks and may act as technological substitutes for wetlands. Restoring an additional site will increase benefits more when there are fewer natural or technological substitutes. Thus, the existence of either other wetlands or gray infrastructure can reduce the value of flood reduction benefits from a wetland restoration, depending on their locations and the size of the storm (Brander et al. 2012; Brander et al. 2013; deGroot et al. 2012).

To evaluate natural substitutes, estimate the area of existing wetlands within a 2.5 mile radius of the site. To evaluate technological substitutes, look for dams, levees, or other gray infrastructure between the restoration site and the flood zone 2.5 miles downstream.

If using the FEMA flood maps to identify assets at risk, note that often infrastructure such as dams and levees have already been considered in the modeling used to create these maps. Since these flood maps are often based on observed gage flow, in some ways they also consider pre-existing wetlands. This implies that substitutes have already been considered and do not need further assessment. Also, in the northeastern U.S., many dams are "run of the river," meaning they have non-functioning structures and therefore provide very little flood water retention. If this is the case, they will not serve as substitutes for wetlands.

In the checklist, note any dams, levees or other gray infrastructure that is able to reduce flood waters between the restoration site and the area where people may benefit (Question 2). Note the number or percent cover of existing wetlands within a 2.5-mile radius of the wetland restoration site. A higher number for either of these measures indicates lower value for the restoration of an additional site.

For our example application in the Woonasquatucket, we noted gray infrastructure within 2.5 miles downstream of the restoration sites. We also calculated the percent of the area within a 2.5 mile radius around the sites that was already wetlands, using the National Wetland Inventory dataset (US FWS 2014).

For a more detailed assessment…

Substitutes and scarcity are specific to the people who benefit. Rather than identifying the number or percent cover of existing wetlands within a 2.5-mile radius of the restoration site, a more accurate estimate is the number or percent cover of existing wetlands within a 2.5-mile radius and upstream of assets protected by the restoration site.

C. Quality of complements

This is not applicable for flood risk reduction.

D. Strength of people's preferences

People who benefit from flood risk reduction will value those benefits differently based on their risk perception. Values typically increase following a flood or in other cases where people's awareness of the risks is heightened (Daniel et al. 2009). The availability of or participation in flood insurance programs can also influence people's perception of risk. Age, education and environmental behavior can all influence risk perception as well (Martin-Lopez 2012).

In the checklist, indicate (yes/no) if people who benefit are aware of and concerned about flood risk in their location. Information such as news coverage of recent flooding, flood insurance program participation or local knowledge can all be used to determine this.

For our example application in the Woonasquatucket, we assumed people who benefit are aware of and concerned about flooding throughout the watershed, because of recent large floods.

For a more detailed assessment…

By engaging the public or stakeholders, you may learn more about their risk perceptions and concerns regarding flooding.

Question 4: Social equity and other concerns

Many characteristics of the affected population can make them more socially vulnerable in the face of floods, and increase the time and resources it takes for them to recover after a flood. Lower income communities are likely to be more socially vulnerable to flood risks. Daniel et al. (2009) found a lower willingness to pay for reduced risk exposure in areas with higher income. Higher income allows people to pay for insurance to reduce the costs of floods, mitigation actions on their property (such as elevating their home) to decrease damage, or replacement and repairs after a flood. The Social Vulnerability Index (SoVI; Cutter 2003) combines several statistically-relevant socio-economic indicators, including income, into an index that can be used to compare vulnerability of different populations.

For our example application in the Woonasquatucket, we estimated the SoVI for each site.

Step 3 in Action—Compile Benefit Indicators: *Scenic Views*

Question 1: Can people benefit from the ecosystem service?

For people to benefit from an improved scenic landscape due to restoration, people must be able to see the landscape, and it must be aesthetically pleasing compared to pre-restoration.

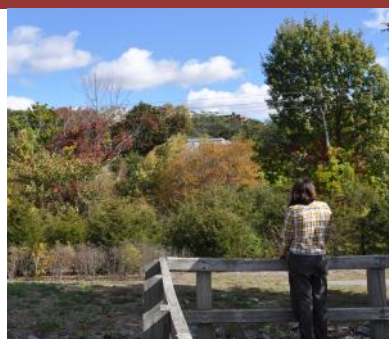


Photo by: Rick McKinney

A. Is there evidence of demand for the service?

If people are able to view the site, either from nearby homes or from transportation networks that pass within view of the restoration site, then there is assumed to be demand.

In the checklist, mark yes if the site is believed to be visible from homes, roads, or trails.

For our example application in the Woonasquatucket, we knew from Google Street View that the Greystone site would be visible from homes and roads; and, using satellite imagery, that site #448 would not be visible. Normally, if there is evidence that there is no demand no further assessment would be necessary. To be sure, we still assessed how many people benefit for both sites, and confirmed for site #448 that there were no people within the benefits area.

For a more detailed assessment…

You may engage stakeholders or the public to determine whether people care about scenic views in the area, and whether the site will provide views that people appreciate.

B. Are any necessary thresholds of quality or quantity met?

To provide scenic view benefits, restored areas should contain features and characteristics that people enjoy. Even if a restored site is not aesthetically notable, it may increase scenic view benefits if it replaces or obscures areas of previous visual blight common to urban settings. One way to screen for this is by identifying the previous land cover at the site as a baseline for comparison (Bagstad et al. 2011).

Features and characteristics that people like to look at do not always correspond with higher wetland functioning. For example, undisturbed wetlands function better, but people may negatively perceive them as "weedy" and un-maintained.

Although restoration sites must be large enough to influence the viewscape, previous work has shown that sites less than 0.75 acre may still provide benefits (Tapsuwan et al. 2009).

In the checklist, mark yes if you expect the site to have features or characteristics, such as presence of open water, that improve the scenic view.

For our example application in the Woonasquatucket, we assumed all sites will have appeal.

C. Is specific infrastructure or other "complementary input" needed and, if yes, is it available?

No other inputs are necessary for people to enjoy scenic views.

If questions A and B are answered "yes," then people are able to benefit.

Continue to the next question.

If not, continue to the next benefit.

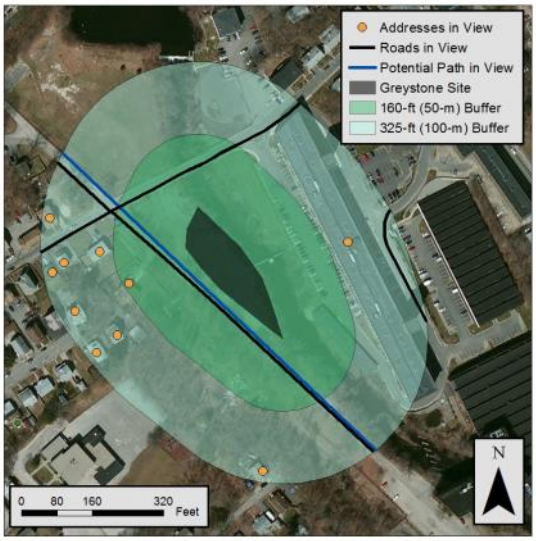
Question 2: How many people benefit?

For people to benefit from a scenic landscape, they must be within visible range and have an unobstructed line of sight to the landscape. In open areas, the visible range can extend very far. Although features in the background affect scenic view quality, most urban sites are too small to influence a large viewscape and only affect the foreground. In an urban context, there may also be obstructions between the viewer and the site.

Visibility and viewshed models can be used to estimate the areas visible from individual residences (Bagstad et al. 2014; Sander and Polasky 2009; Sharp et al. 2015), but applying these models can be time- and computationally-intensive. Without using these models, you may assume that people with homes neighboring the site and any natural area around it are most likely to be able to enjoy seeing the restored site (deGroot et al. 2010). EPA's EnviroAtlas (Pickard et al. 2015) generalizes this proximity and identifies the population within 50 meters (about 160 feet) as having potential window views of water. Holzinger (2014) also used 50 meters to identify houses likely to have views, but suggested that houses further away, at 100 meters (about 325 feet), are also likely to see the site, though at a lower probability since the houses directly bordering the site sometimes obstruct the view. Other work has used less conservative proximity generalizations (1 km, Sander and Polasky 2009; 0.5 miles, Wainger et al. 2001), and although some people at those distances may be able to see the site, it is much less likely.

In the checklist, record the number of people, using addresses, parcels or population data, within 160 feet/50 meters and from 160 to 325 feet/100 meters from the site. Note whether trails or well-traveled roads pass within 325 feet of the site.

For our example application in the Woonasquatucket, the map shows the process followed to evaluate the Greystone restoration site. First, we created two buffer areas around the site, one covering 0 to 160 feet (dark green) and one covering >160-325 feet (light green). Next, we identified addresses within these distances (E-911 addresses in orange, RIGIS 2014). Imagery such as that shown in the map also allows for easy identification of homes in visible range of a site. Roads were identified using a dataset (E-911 roads in black, RIGIS 2013); but again could easily be identified from imagery. There were no existing trails near the site, but a proposed bike path was identified (bike paths, RI DOT 2010).



Example of map used to assess addresses (orange), roads (black) and trails (blue) within potential viewing distance of Greystone Restoration Site.

For a more detailed assessment…

If metrics gauging how many people use trails or roads within viewing distance (for example, traffic counts) are available, you can use them to estimate the number of people who benefit from scenic views along these routes. Alternatively, you can rank roads or trails based on type (for example: a local road or a county highway, a local trail or a state park trail).

Question 3: How much are people likely to benefit?

A. Quality of the service

Because enjoyment of aesthetics is subjective, the features and characteristics of a landscape that one person enjoys may not be enjoyed universally. Features that many people prefer include open water and views with diverse land cover types and vegetation (Bagstad et al. 2011; Dramstad et al. 2006; Gobster and Westphal 2004; Mougiakakou et al. 2005; Nassauer 2004; Ode et al. 2008; Radford and James 2013; Sander and Polasky 2009).

People prefer a larger total visible area (Dhami and Deng 2010), a characteristic that relates to site openness (Radford and James 2013) and relief (Mougiakakou et al. 2005). It is difficult to estimate the total visible area from a residence without visibility and viewshed modeling. However, because the restored site is only one component of the entire viewscape, the smaller or farther away the site is and the larger the total viewscape, the less impact the site restoration is likely to have on the scenic quality of the view.

In the checklist, note any features or characteristics of the restoration site that give it particular aesthetic interest, such as open water, varied vegetation, size, and relationship to the larger landscape.

For our example application in the Woonasquatucket, we assumed both sites would have features or characteristics of interest based on images of the sites from Google Street View and satellite imagery.

B. Substitutes for the service and scarcity of the service

Technological substitutes do not exist for scenic views of nature, although the built landscape may provide different types of aesthetic benefits, such as city skylines. People who already benefit from being able to see one wetland can still benefit from seeing additional wetlands within the viewscape. However, these additional benefits will be smaller than if there were no pre-existing wetlands. People who receive scenic view benefits are able to receive benefits from substitute wetlands or other open water in all directions.

EPA's EnviroAtlas (Pickard et al. 2015) calculated the percent of residential populations, based on population density, with potential views of water for select communities. Where available, this dataset estimates how many residents in an area may already have views of open water, giving an estimate of the availability of substitute views.

To determine the number of substitutes, we suggest doubling the outer buffer used to determine how many people benefit (Question 2), to 200 meters (approx. 650 feet), and estimating the area of wetlands and open water within this distance. A higher area indicates more substitutes, and thus lower value for an additional site.

In the checklist, note the total amount of wetlands and open water within 650 feet of the restoration site.

For our example application in the Woonasquatucket, we calculated the percent of the area around the site that is wetlands or water using the National Wetland Inventory dataset (US FWS 2014).

For a more detailed assessment…

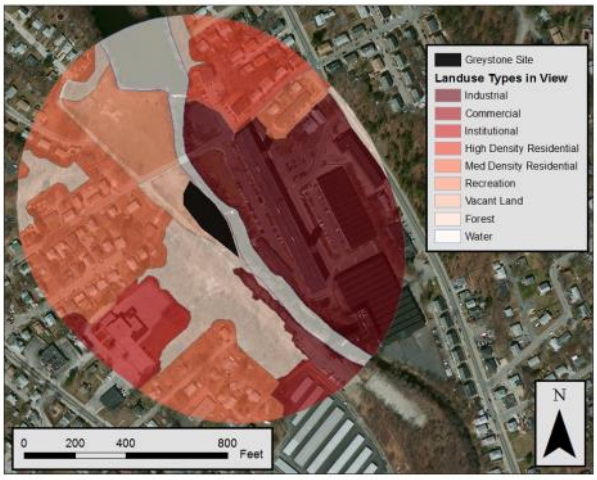
Substitutes and scarcity are specific to each person who benefits, so ideally the number or area of visible wetlands or open water should be attributed to each residence within viewing distance of the proposed restoration site. To evaluate this, instead of creating a buffer around the wetland restoration site, create a 100 meter (approx. 325 foot) buffer around each residence that may benefit and estimate the density of wetlands or open water in the buffer area..

C. Quality of complements

As discussed in the service quality section, people generally prefer diversity of land cover and vegetation in the landscape. While some land cover types, such as urban or industrial, may have negative aesthetic values; others, such as forests, grassland, and even light agricultural, when paired with wetlands, may increase the total aesthetic value.

In the checklist, add up the areas of other natural land cover within 650 feet of the restoration site, and note their types.

For our example application in the Woonasquatucket, we determined land cover types using the Rhode Island landuse dataset (RI DEM and RI DOA 2014). For other locations, the nationally available National Land Cover Database (USGS 2014) or imagery may be used. In the example map for the Greystone restoration site, natural land cover types (shades of green) include recreation, vacant land, and deciduous forest.



Map of land cover types around the Greystone Site.

For a more detailed assessment…

Complements are specific to each person who benefits, so ideally the diversity of land cover types can be more accurately estimated for each residence rather than the restoration site. For each residence, add up the number of other natural land cover types within 325 feet.

D. Strength of people's preferences

Different users have different perceptions of what they find scenic and attractive about a landscape (Nassauer 2004). These differences do not seem to correspond to socioeconomic indicators, but may be influenced by culture and location (Gobster and Westphal 2004). As listed above in the section on quality of views, some aspects of landscapes are more universally preferred. In order to better understand preferences in your location, this would be a place to involve the public to learn about their visual preferences and to potentially incorporate aspects that satisfy local preferences in your restoration.

In the checklist, note any relevant details regarding people's visual preferences and how well the restored site is likely to meet them.

For our example application in the Woonasquatucket, we assumed all people who may benefit from either site have the same strength of preference for scenic view benefits.

Question 4: Social equity and other concerns

In areas with high population density and little greenspace, a vegetated view or view of open water can provide benefits to populations with little access to nature.

For our example application in the Woonasquatucket, we estimated the SoVI for each site.

For a more detailed assessment… You may also note whether populations that are underserved by natural amenities are likely to view the site.

Step 3 in Action—Benefit Indicators: *Environmental Education*

Photo by: WRWC

Question 1: Can people benefit from the ecosystem service?

For people to benefit from increased environmental education opportunities because of a restoration, the site must be accessible to learners and offer habitats of high enough quality to attract wildlife.

A. Is there evidence of demand for the service?

Many metrics are available as indicators of demand for environmental education. Programs (K-12 programs, family programs, field trips, informal education, self-guided tours, citizen involvement, offender education, and so on) that take place at a site will indicate demand (Burkhard et al. 2014; Loomis and Paterson 2014). Where there are no current opportunities for environmental education, requests for programs may indicate demand for future opportunities (Burkhard et al. 2014; Moore and Hunt 2012).

In the checklist, mark yes if there are indications that people care about and might participate in environmental education at or near the restoration site.

In our example application, the Woonasquatucket River Watershed Council has sponsored several educational programs, including Fish in the Classroom and River Adventures After School, indicating demand for environmental education in the watershed.

B. Are any necessary thresholds of quality or quantity met?

To provide educational benefits, restored areas should contain features or wildlife with special educational or scientific interest (deGroot et al. 2010). The probability of features or wildlife being present increases as habitat quality increases, but a site does not need to have high habitat quality to provide educational benefits.

In the checklist, mark yes if you expect the site to support wildlife or have features of educational interest.

In our example application in the Woonasquatucket, we assume all sites will be able to support wildlife of educational interest after restoration.

C. Is specific infrastructure or other "complementary input" needed and, if yes, is it available?

While there are many complements that can increase educational benefits, no other inputs are necessary for people to learn from environmental educational opportunities.

If questions A and B are answered "yes," then people are able to benefit. Continue to the next question.

If not, continue to the next service.

Question 2: How many people benefit?

Because learners must travel some distance to the wetland site to benefit from environmental education, determining who may benefit will depend on how far people are willing to travel. The choice of distance can lead to large variations in the estimated number of people who benefit. In the literature, distances children traveled from school to wetlands for educational field trips ranged from 1/2 mile to 2 km (1 1/4 mile) to over 51 min by vehicle (Holzinger 2014; Moore and Hunt 2012).

Urban wetlands, which may lack high quality habitat or educational facilities, are more likely to attract users who are within walking distance than those who will drive long distances. Studies have used a 5-6 minute walking distance as appropriate for children (Handley et al., 2003), which equates to 100-400 meters (approx. 1/10 to 1/4 mile). Based on this, we suggest a 1/4-mile distance to identify schools and other educational institutions that could receive environmental education benefits.

In the checklist, record the number of schools within 1/4-mile of the restoration site.

In our example application in the Woonasquatucket, the Graniteville public school and Johnston childcare center are both within 1/4 mile of the Greystone restoration site (shown in map; RI DOA 2008).

Map showing schools within 1/4 mile of the Greystone site.

For a more detailed assessment…

Much nature-based education takes place outside of learning institutions during unstructured play. To account for this type of educational benefit, a 1/4-mile buffer can be applied to count how many households are within walking distance of the site. Since children aren't the only potential users, this also accounts for adults receiving environmental education benefits. This metric is particularly relevant if the site has educational signage or other features that make it more suited for education (See Question 3, below).

Question 3: How much are people likely to benefit?

A. Quality of the service

Even wetlands with poor habitat quality may have unique features or wildlife that are valuable for education. However, integration with open spaces, presence of charismatic species, perceptions of ecosystem health, and opportunities to see wildlife and megafauna all add to the level of environmental education benefits received (Loomis and Paterson 2014; Martin-Lopez et al. 2011; Moore and Hunt 2012). Additional wetland and other natural habitat areas around the site often increase habitat quality and educational opportunities on the site. Functional assessments of habitat quality could be used as an indicator of learning opportunity service quality.

In the checklist, note any habitats, features or wildlife that give the site particular educational interest.

In our example application in the Woonasquatucket, we used scores from the previously conducted functional assessment (Miller and Golet 2001) to account for service quality.

B. Substitutes for the service and scarcity of the service

While museums and zoos offer similar educational benefits, they are not direct substitutes for environmental education gained through interactions with plants and animals at natural sites. If there are closer wetlands that are equally accessible and of equal quality, or equidistant wetlands that are of higher educational quality, it is likely that educational programing will take place there instead. A simple way to estimate the number of substitute wetlands around a restoration site is to double the area used to identify people who may benefit (1/4 mile), resulting in a 1/2-mile buffer, and count other wetlands that may provide educational benefits within this area.

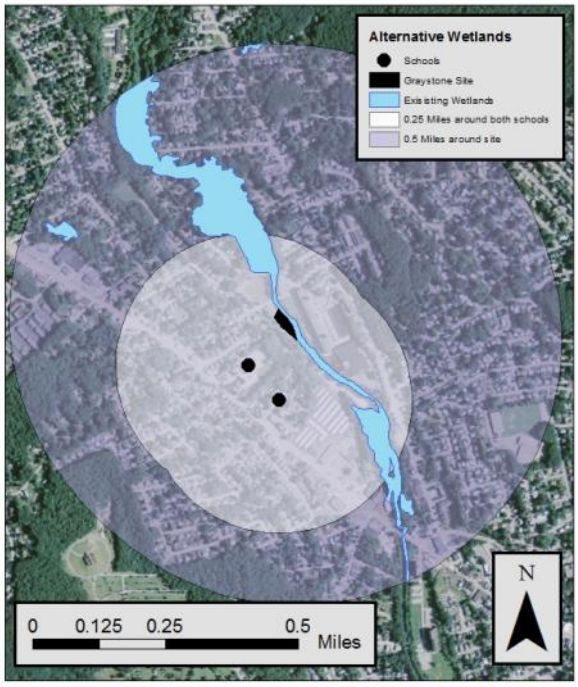
In the checklist, note how many wetlands suitable for educational use are within a 1/2-mile distance of the restoration site.

In our example application in the Woonasquatucket, we mapped a 1/2-mile buffer around each restoration site and measured the density of wetlands as percent area using the National Wetland Inventory dataset (blue; US FWS 2014).

For a more detailed assessment…

Substitutes and scarcity are specific to the people who benefit rather than the site where they originate. A better way to assess scarcity of wetland learning opportunities is to measure the density of wetlands within 1/4-mile distance from all educational institutions.

In our example application in the Woonasquatucket, the Graniteville public school and Johnston child care center are both within 1/4 mile of the Greystone restoration site so we chose to identify the density of wetlands within 1/4-mile distance of those institutions (shown in map as pink area around black points), using the National Wetland Inventory (blue areas in the map; US FWS 2014).



Map showing 1/2-mile buffer (purple) around the Greystone restoration site (black), and 1/4-mile buffers (pink) around the two educational institutions in the neighborhood. Existing wetlands within these areas are shown in blue.

C. Quality of complements

Factors that allow for and enhance educational opportunities are very influential in determining how much people may benefit from environmental education opportunities. Educational signage, interpretive centers, and rangers and other educational staff are all examples of complements that increase educational benefits (Holzinger 2014; Loomis and Paterson 2014; Moore and Hunt 2012). Paths, boardwalks, boat launches, bike racks and other ways to improve access may also increase educational benefits. The types, and in some cases density (e.g. number of signs per acre), of complements can be used as measures of their overall quality (Burkhard et al. 2014).

In the checklist, record the types and quality of complementary infrastructure available at or proposed for the restoration site. Note the quality, number or density of each if applicable.

In our example application in the Woonasquatucket, we assumed all restoration sites would receive the same level of educational signage describing the restoration.

D. Strength of people's preferences

Although all the people identified in Question 2 are able to receive educational benefits, some educational institutions are more likely to take advantage of these learning opportunities than others, and some wetlands will be preferred over others.

It can be very difficult to characterize what makes a wetland a good candidate site for educational use and which educational institutions are more likely to take advantage of such learning opportunities. Schools with after-school programs may be able to offer more short field trips. Having teachers who are interested in using wetlands in their curricula can also make a big difference, as they are often able to bring in other interested teachers. Engaging these interested teachers can help you learn what wetland characteristics are preferred for integration with their existing or proposed curricula.

In the checklist, note yes/no if the wetland has characteristics that allow for integration with the curricula of educational institutions expected to benefit.

In our example application in the Woonasquatucket, we assumed both sites would have characteristics that would appeal to nearby educational institutions.

For a more detailed assessment…

Benefit metrics are likely to be specific to each educational institution. One characteristic of educational institutions that makes them better able to take advantage of educational opportunities in wetlands is after school programs. For each educational institution, note the types of programs provided.

Question 4: Social equity and other concerns

Children in more densely populated areas, and especially those of minority ethnic groups, are less likely to have access to environmental education opportunities (UK NEA 2011).

For our example application in the Woonasquatucket, we estimated the SoVI for each site to evaluate social equity.

For a more detailed assessment…

You may want to note whether the educational institutions that will potentially benefit from the restoration serve children from highly urbanized areas and/or minority children.

Step 3 in Action—Compile Benefit Indicators: *Recreation*

Photo by: WRWC

Question 1: Can people benefit from the ecosystem service?

For people to benefit from increased recreational opportunities due to restoration, they must be willing and able to travel to the site to recreate. Depending on the type of recreation, the site may need to have certain complementary inputs to support recreation of that type.

A. Is there evidence of demand for the service?

If people are interested in a recreational activity that the restoration site supports, then there is demand for increased recreational opportunities of that type (Bagstad 2013). There are several ways to measure current use of resources for recreation, such as the number of visitors and annual recreation visitor days (Burkhard et al. 2014; Layke 2009; Loomis and Paterson 2014; Martin-Lopez 2014), or photos taken during recreation (Sharp et al. 2015). Where there are no current opportunities for a given type of recreation, results of questionnaires or participation in activities associated with that type of recreation (i.e. memberships, licenses, etc.) may indicate demand for future recreation opportunities (Bagstad et al. 2011; Burkhard et al. 2014).

For a general assessment, indicators of demand for all types of recreation are adequate; but if assessing a specific type of recreation (for example, canoeing), use demand indicators specific to that activity, such as the number of people who canoe in local waterways.

In the checklist, mark yes if people care about recreation at this location.

In our example application in the Woonasquatucket, we assumed demand at all sites.

B. Are any necessary thresholds of quality or quantity met?

Smaller sites are unable to support certain types of recreational activities. Handley et al. (2003) found that people did not regularly visit woods of less than 2 hectares (5 acres). Koppen et al. (2014) used the Norwegian Ministry of Environment's 0.5 hectare (1.2 acre) minimum size for play and recreation areas, but recognized that this might eliminate some smaller green spaces that are important for children. A wetland restoration may be a smaller component of a larger green space, so caution should be exercised in using too small a size threshold.

Sites may have natural features or qualities that make them unsuitable for specific types of recreation. For example, poor water quality may make swimming unsafe, or contaminated fish will limit fish consumption. Depending on the types of recreation being included, you may need to further characterize the site's ability to provide recreational opportunities.

In the checklist, list the types of recreation anticipated at the site, and indicate whether the site is sufficient to provide those types of recreation (yes or no).

In our example application in the Woonasquatucket, we assumed all sites would be able to support some form of recreational activity.

C. Is specific infrastructure or other "complementary input" needed and, if yes, is it available?

Certain recreational activities require additional complements (features or infrastructure) that allow people to engage in that activity. Access points are required for most recreational activities, since users must be able to access the site to be able to recreate there. Complements specific to recreational activities are common. For example, hiking and biking require trails, and boating requires boat launch ramps.

If conducting a general assessment of recreational benefits, it may be practical to list recreational activities supported by available features or infrastructure. This list is useful as it allows you to prioritize sites by the recreational activities supported without doing an entire assessment specific to each activity. For example, if two sites are otherwise equivalent but one has a biking trail, the presence of the trail prioritizes it without needing an entire assessment specific to biking recreation.

In the checklist, indicate (yes/no or NA) if any necessary complementary inputs exist for the relevant activities.

Our example application in the Woonasquatucket used a generic assessment not specific to any recreation types, so we assumed required complements to be available but noted any complementary inputs that would enable specific types of recreation in Question 3 part C.

If questions A, B and C are answered "yes," then people are able to benefit. Continue to the next question.

If not, continue to the next benefit.

Question 2: How many people benefit?

The number of people able to benefit depends on how far they are willing to travel to reach a site to recreate. As the required travel distance increases, the burden to the user increases, in both travel time and associated travel costs (Holzinger 2014; Whitehead 2009). For users to travel farther, their perception of how much they will benefit (Question 3) must increase.

Infrastructure that reduces the burden of traveling to a site will increase how many people can benefit. This includes things like sidewalks or bike paths that provide access via alternative transportation methods, and more direct routes via roads that reduce travel times (Brander et al. 2006; Chan 2006; Riechers 2016). In an urban context, users are more apt to use public transportation, making nearby bus stops relevant (Riechers 2016).

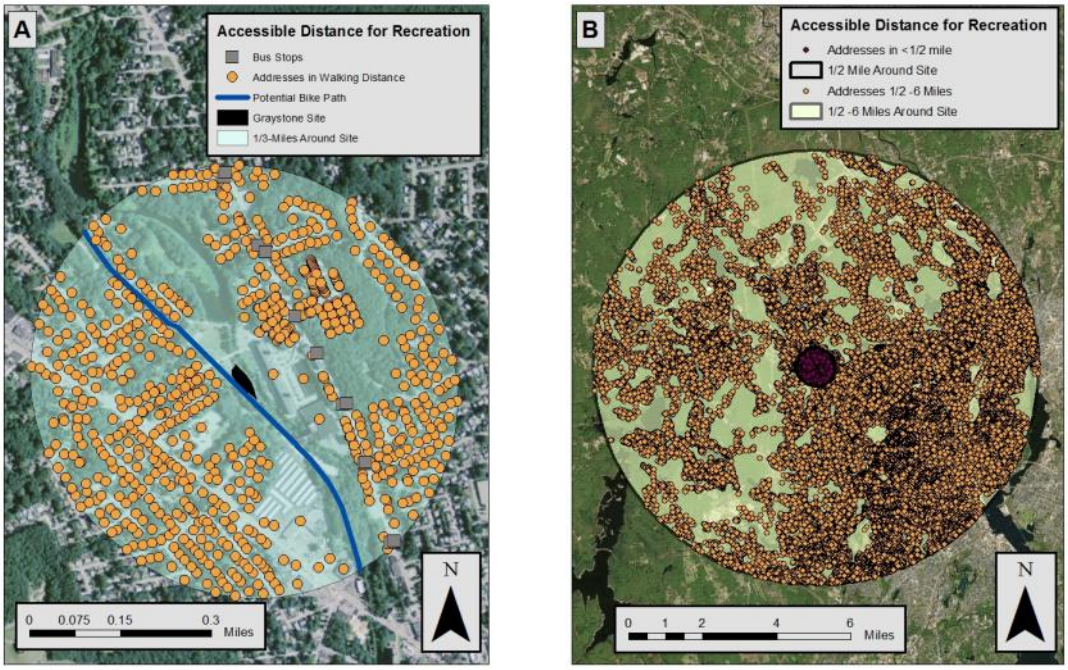
For daily recreational trips, 80 % of users walk to the site (Handley 2003). Most studies have suggested 5-10 minutes as the threshold for walking to a site, which translates to a distance of 100-500 meters (around 1/10 to 1/3 mile) (Handley 2003; McPhearson et al. 2013; Trust for public Lands 2015).

Higher quality sites may attract people from greater distances who are driving from their residence to recreate at the site. Studies have suggested a wide range of travel times (30-90 minutes) and distances (from 1/2 mile to 6 miles) (Handley 2003; Lautenbach et al. 2011; Riechers 2016; Holzinger 2014; Sherrouse et al. 2011; Trust for Public Land 2015).

In the checklist, indicate the number of people who are within walking distance, using a 1/3-mile buffer from the site. Indicate (yes/no) if there are bike trails and bus stops within the same 1/3-mile buffer.

In the checklist, indicate the number of people who are within easy driving distance of the site based on 1 /2-mile and 1/2 to 6-mile buffers.

For our example assessment in the Woonasquatucket, the maps below show the analysis for the Greystone restoration site. We included addresses based on the E-911 address dataset (orange, RIGIS 2014), bike trails based on existing or proposed trails (blue, RI DOT 2010), and bus stops based on RI Public Transit Authority dataset (gray squares, RIPTA 2016). Map A shows the 1/3-mile buffer around the site, and Map B shows the 1/2-mile and 1/2 to 6-mile buffers.



Map A shows addresses (orange circles); and features, both bus stops (gray squares) and a proposed bike path (blue line), that are within a walking distance of 1/3 mile of the Greystone site (area highlighted in green). Map B shows all addresses within a short (0.5 mile, addresses in purple) or longer (0.5-6 miles, addresses in orange) driving distance.

Question 3: How much are people likely to benefit?

A. Quality of the service

Several characteristics of a site may enhance the recreational opportunities available there. Site naturalness is one such characteristic (Handley 2003). Particularly in an urban context, a site that feels unaltered and natural can offer an opportunity separate from the urban setting. The scenic beauty of the site (see Scenic Views section) can enhance recreational experiences as well (Gobster 1995; Loomis and Paterson 2014). Larger sites may also enhance the recreational opportunities available (Handley 2003; Loomis and Paterson 2014; Moore and Hunt 2012).

In the checklist, record the total green space area including and adjacent to the restoration site; that is, the total of the restoration site area and adjacent publicly accessible green space.

For our example assessment in the Woonasquatucket, we measured the area of the restoration site and the area of its parcel based on landuse (RI DEM and RI DOA 2014). For example, the Greystone restoration site is on landuse designated as vacant and adjacent to landuse designated as recreation so we included the area of these in the total green space area.

B. Substitutes for the service and scarcity of the service

Substitutes are especially important for assessing recreational benefits because users often prefer specific sites. However, several guidelines have suggested using scarcity metrics as a goal for providing recreational opportunities. For example, in the UK Handley (2003), recommends 1 hectare (2.5 acres) of green space be available for every 1000 people. Therefore, below this amount, one can assume that the benefits of additional recreational areas do not decrease with quantity.

One way to estimate potential substitutes for those who benefit from the restoration site is to double the extent of the restoration benefit areas (1/3, ½ and 6 miles become 2/3, 1 and 12 miles) and calculate total pre-existing green space areas in that radius.

In the checklist, quantify available substitute sites within each travel distance buffer (2/3, 1, and 12 miles) based on number of sites and total area.

For our example assessment in the Woonasquatucket, we estimated areas of wetlands and green spaces using existing spatial datasets (wetlands, US FWS 2014; and landuse, RI DEM and RI DOA 2014).

For a more detailed assessment…

A more accurate estimate would quantify substitutes for each person who benefits. This can be done by estimating a travel area for each person (1/3, ½ and 6 miles) and assessing existing recreation.

C. Quality of complements

Higher quality complements, such as infrastructure or other features, may enhance certain types of recreational benefits (see Question 1). This should be evaluated for each recreational activity separately.

In the checklist, note the recreational activities of significance that the site can support and describe the features and infrastructure that further enhance recreational benefits. Mark yes if the site has complementary inputs that are either beyond the necessary minimum, or of particularly high quality for the recreational activities at the site.

For our example assessment in the Woonasquatucket, we identified state outdoor recreation facilities (RI DEM 2014), fishing and boating access (RI DEM 2012), bike paths (RI DOT 2010), and DEM hiking trails (RI DEM 2015) that intersect or are adjacent to restoration sites.

D. Strength of people's preferences

User preferences are typically specific to each recreational activity (Bagstad 2013). For example, additional miles of interconnected trail might be preferred by people using the trail for cycling but not as important to those using it for walking. Generally speaking, people prefer recreating in areas that are near the water, have a low slope, are integrated with other areas and feel safe (Handley 2003; Moore and Hunt 2012; Sherrouse et al. 2011). Sites that users have more place attachment to, such as those with cultural significance, or that users have been visiting for a long time are often preferred (Bagstad et al. 2011; Handley 2003; Riechers 2016)

In the checklist, mark yes if the site has additional features or characteristics that people prefer. Describe those features or characteristics.

For our example assessment in the Woonasquatucket, we used a scenic areas dataset (RI DEM 1989) to identify if the site might overlap or be adjacent to areas with extra scenic appeal, and historic sites (RIHPC 1995) to identify if the site might be overlapping or adjacent to areas with extra cultural appeal.

Question 4: Social equity and other concerns

People in more densely populated areas, and especially those with fewer resources and less access to transportation, are less likely to have access to outdoor recreational opportunities and are more likely to benefit from the health benefits of outdoor recreation.

For our example application in the Woonasquatucket, we estimated the SoVI for each site to capture these concerns.

For a more detailed assessment…

You may indicate whether the populations that can benefit from the site for recreation (Question 2) are from densely populated areas, or are dependent on public transportation.

Step 3 in Action—Compile Benefit Indicators: *Birds*

Photo by: USFWS National Data Library

Question 1: Can people benefit from the ecosystem service?

For people to benefit from increased bird watching opportunities because of a restoration, both birds that people appreciate and people who enjoy watching or hearing the birds must be present. Complementary inputs are not required.

A. Is there evidence of demand for the service?

An estimated 22 % of the US population and 27 % of New Englanders participate in birding (USFWS 2001). If birders recognize the restoration area as a birding area, there will be demand for increased bird watching opportunities (Bagstad et al. 2011). Although it is unlikely that most restored urban wetlands would gain recognition as birding areas, even more of the population enjoys seeing birds around their home (88 %; USFWS 2001) and many people take actions to attract birds to their property (53.4 %; Clucas et al. 2015). These figures from the literature indicate that if people are present, it is likely that some will appreciate birds.

In the checklist, mark yes if there is evidence that people around the site care about seeing and hearing birds.

For our example assessment in the Woonasquatucket, we assumed all sites being assessed had demand for birds.

B. Are any necessary thresholds of quality or quantity met?

To provide bird watching benefits, restored areas should be able to attract species of birds that people like. Areas attract birds when the habitat they provide is of the right type and sufficient quality for a species. Many birds require or prefer access to wet areas such as wetlands. Provision thresholds are met if the proposed restoration site is expected to be of high enough quality to support some of these bird species.

In the checklist, indicate if provision thresholds are met or not (yes or no). If a qualitative or species-based assessment has been done indicate the results for this site.

For our example assessment in the Woonasquatucket, we assumed all sites supported some bird species of interest and applied a more detailed bird habitat functional assessment (see Appendix 3).

For a more detailed assessment…

Quality thresholds of proposed sites can be determined using a habitat function assessment tool such as the one provided in Appendix 3.

C. Is specific infrastructure or other "complementary input" needed and, if yes, is it available?

No other inputs are necessary for people to enjoy watching or hearing birds.

If questions A and B C are answered "yes," then people are able to benefit. Continue to the next question.

If not, continue to the next service.

Question 2: How many people benefit?

Because birds travel different distances from their habitat, the area where people may benefit will vary, depending on the species of bird (see Table 1 in Appendix 3 for ranges of common Northeastern U.S. species). If birders are willing to travel to the area for unique, iconic or migratory bird species, the benefits area will be even larger. For the species considered in our Woonasquatucket example, we have assumed a conservative benefits area of 1/5 mile, based on a typical average range of 1/10 mile, plus 1/10 mile of viewing distance from people. We assume that the entire population within the 1/5 mile radius may benefit from bird watching.

People may also travel to or through the benefits area. People may go there for work or recreation, even specifically for recreational birding. People may also enter the area while en route to other locations, for example while hiking a trail or while commuting to work. Although it is difficult to predict and quantify how many transient people will be in the area around a site, infrastructure such as trails or roads are potential indicators.

In the checklist, estimate the number of people within 1/5 mile of the site. This may be done either by counting the number of residences (and possibly businesses), or by estimating the population density within the benefits area. Note whether trails or well-traveled roads pass within the same 1/5 mile radius.

For our example assessment in the Woonasquatucket, we included addresses based on the E-911 dataset (RIGIS 2013). Alternatively, this information can be gathered from imagery, property parcels or census population densities.

For a more detailed assessment…
If metrics gauging how many people use trails or roads (for example, traffic counts) are available, you can use them to estimate the number of people who benefit from bird watching along these routes. Alternatively, you can rank roads or trails based on type (for example, a seasonal road or a county highway; a local trail or a state park trail).

Question 3: How much are people likely to benefit?

A. Quality of the service

The best bird watching sites are those that provide the best chances of seeing rare and unique species or have the widest variety of bird species (Bagstad et al. 2011; Naidoo 2005; Sharp et al. 2015).

Though urban sites are less likely to attract rare or unique species, sites with higher quality bird habitat will be more likely to attract a variety of species.

In the checklist, indicate (yes/no) whether the site is expected to support rare or unique species.

For our example assessment in the Woonasquatucket, we applied a functional assessment (Appendix 3) to determine how the sites compared in terms of bird habitat quality.

For a more detailed assessment…
The quality of proposed sites can be determined using habitat function assessments and tools such as that provided in Appendix 3. Results from these functional assessments can be compared across sites to rank site quality. A functional assessment may also be used to predict the bird species expected at the site, an indicator of the potential quality of bird watching benefits.

B. Substitutes for the service and scarcity of the service

The issue of substitutes with regard to bird habitat in an urban or urbanizing setting can be complicated. While, in general, adding a site to an area that has many existing sites will be less valuable than adding a site to an area with fewer existing sites, there may be habitat synergies that can lead to increasing benefits with additional sites. This is because adding a site may increase total area enough to either attract more of the same species, increasing the probability of viewing those birds, or attract new bird species to the area (Brown and Dinsmore 1986).

Effectively, pre-existing wetlands can often be seen as complements, increasing values by providing critical thresholds of habitat for more birds and species, rather than as substitutes, which diminish the value of additional sites. As the availability of wetland bird habitat increases, the additional quantity and quality of benefits gained from restoration (marginal benefits) are expected to become less valued after some threshold is reached. Wetlands in urban areas are unlikely to surpass this threshold. Because of the complexity of evaluating substitutes, it is beyond the scope of this rapid assessment and will require additional professional judgment or modeling to evaluate.

C. Quality of complements

Complements add value to the benefits received in one area when compared to the same benefits in an area without those complements. In the case of bird watching, complements might include built infrastructure, such as facilities that attract birds or enhance bird observation (for example, viewing platforms); or natural infrastructure, such as bird migration corridors or additional nearby bird habitat.

In the checklist, note any complementary infrastructure or habitat that may add to the value of benefits.

For our example assessment in the Woonasquatucket, we identified whether the site was within 1/5 mile of natural resources corridor areas designated in the statewide Greenways plan (RI DOA 1995). The score determined using the functional assessment already accounted for nearby complementary habitats.

D. Strength of people's preferences

The majority of at-home bird watchers, 74 % of whom are beginners (USFWS 2001), prefer birds that are aesthetically pleasing or have pleasant songs (Belaire et al. 2015). Rare and unique species become more important to more advanced birders.

The value people place on birds and birdwatching is not typically dependent on their income, but may be higher with increased age (Belaire et al. 2015; Clucas et al. 2015).

In the checklist, note whether the people who may benefit are expected to have above average interest in bird watching or include at-home bird watchers.

For our example assessment in the Woonasquatucket, we assumed populations around both sites would include some at-home bird watchers.

Question 4: Social equity and other concerns

People in more densely populated areas, and especially those with fewer resources and less access to transportation, are less likely to have access to bird watching opportunities, so providing these opportunities to urban residents can improve access. Also, bird watching tends to be less common among minorities (USFWS 2001 found 24 % of white respondents were birdwatchers compared to 9 % of Hispanic, 6 % African American or Asian respondents).

For our example application in the Woonasquatucket, we estimated the SoVI once for each site to capture social equity concerns.

For a more detailed assessment…

Indicate whether the populations who can benefit (Question 2) are from densely populated areas, are dependent on public transportation, or have high minority populations.

Step 4: Summarize the Benefit Indicators

Question addressed in this step:

- What are the results of the assessment?

What does this step do?

This step summarizes the results of the indicators assessment.

Applying this step:

Once you have conducted the assessment, you will want to summarize the data gathered to facilitate comparisons. The checklist tool will do this for you automatically, summarizing all entries from Step 3 in a single table. If you are not using the tool, you may create a similar summary table for your project.

When compiling the indicators, you may not answer all of the questions. In some cases, a particular indicator may not be applicable, either because that aspect is not relevant (for example, complements are not relevant for flood protection) or because a particular benefit is not provided at a site. In other cases, data may not be available to answer a particular question or you may decide that the question is not important for a particular decision.

In the summary table provided by the checklist tool, information that was not filled in in Step 3 is shaded in black, and questions that are not applicable appear in gray, marked "NA." When a question is not applicable, it will not be applicable at any site, so will not be useful for distinguishing between sites. Similarly, when a question is not answered because data are not available, the indicator will not be useful for comparing sites. When a question is not answered because a particular benefit isn't provided at a site, the information still can be useful for decision making.

The indicators include quantitative information, qualitative information, and narrative information. In the table, quantitative information is summarized based on the mean value of all data collected. Values indicating higher benefits relative to the mean are color-coded in blue and values indicating lower benefits relative to the mean are coded in red. For most measures, higher benefits are indicated by higher values, so that values greater than the mean are in blue and those less than the mean are in red. However, for the scarcity/substitute measures, higher benefits are indicated by *lower* values, so that values below the mean are in blue and values above the mean are in red. Quantitative information that does not vary across sites is informative, but is not useful for comparing sites, so it is presented in gray.

Qualitative information, such as yes/no indicators, is also summarized using color-coding. In most cases, a yes value indicates higher benefits and appears in blue, while a no value indicates lower benefits and appears in red. Again, the substitutes indicators are an exception, where no indicates higher benefits and appears in blue, and yes indicates lower benefits and appears in red. If all sites receive a negative response to a particular question, this is informative but not useful for comparing sites, so is presented in gray. If all sites receive a positive response to a question, this is informative, and additional narrative information may distinguish among sites, so it appears in blue. Many of the indicators with yes/no criteria allowed for additional narrative information, which is not summarized in the summary sheet. This information should be consulted when comparing sites.

The summary presented in Step 4 can be used to compare sites, but not to rank them quantitatively, because the information is not aggregated to a single metric. Step 5 discusses this further.

Step 4 in Action—Summarize the Benefit Indicators

Here, we present an example of the summary table produced by the checklist tool (shown on page 59).

- Blue-colored responses indicate higher benefits, and red-colored responses indicate lower benefits. If both sites have the same color, more information may be needed.
- If a response is in black, no information was entered in Step 3.
- If a question is not applicable it appears in gray with "NA."
- If an earlier response meant that an indicator could be skipped, the indicator that could be skipped appears in gray.

Examples to illustrate the results summary and color-coding:

- Complements are not applicable for flood risk, so are marked "NA" and shaded in gray.
- Site #448 was not visible to people, so scenic views indicators are shaded in gray, because people are unable to benefit.
- The number of people who benefit from bird watching is 298 for Greystone, which is above the mean and shaded in blue; while the number for site 448 is 8, which is below the mean and shaded in red.
- The substitutes/scarcity measure for environmental education is 4.9 % for Greystone (indicating higher benefits, shaded in blue); and 12.4 % for site 448 (indicating lower benefits, shaded in red).
- For Scenic Views, the qualitative question about roads with views of the site is answered "yes" for Greystone (coded in blue) and "no" for site 448 (coded in red).
- The qualitative question regarding existence of dams (to indicate scarcity) for flood risk is answered "yes" for Greystone (indicating lower benefits, coded in red) and "no" for site 448 (indicating higher benefits, coded in blue).
- Questions where both sites have "yes" answers, coded in blue, often have additional narrative information that should be consulted when comparing sites.

Step 4 in Action—Summarize the Benefit Indicators

	Step 4	Summarize the Indicators		Site	
	Benefit	**Indicators for Woonasquatucket Example**		**Site 1: Greystone**	**Site 2: #448**
	**Flood Risk**	3.2 How Many Benefit?	2.5 mi downstream of site and in flood zone	20	6
		3.3.A Service Quality	Area of restoration site (acres)	0.54	3.84
			Features that increase retention volume?	Yes	Yes
		3.3.B Scarcity	Dams and levees 2.5 mi downstream?	Yes	Yes
			Wetlands within 5 mi (number or % area)	9.84	11.2
		3.3.C Complements	NA	NA	NA
		3.3.D Preferences	Are people worried about flood risk?	Yes	Yes
	**Scenic Views**	3.2 How Many Benefit?	Number within 160 ft of site	9	0
			Number within160- 325 ft of site	1	0
			Weighted number who benefit	6.6	0
			Are there roads or trails within 325 ft of site?	No	No
		3.3.A Service Quality	Aesthetic features or characteristics?	Yes	
		3.3.B Scarcity	Wetlands or water within 650 ft (number or %)	7.7	
		3.3.C Complements	Natural land use types within 650 ft (types)	4	
		3.3.D Preferences	Will people find it aesthetically pleasing?	Yes	
	**Environmental Education**	3.2 How Many Benefit?	Education institutions within 0.25 mi of site	2	0
		3.3.A Service Quality	Features/habitat/wildlife of education interest?	Yes	Yes
		3.3.B Scarcity	Wetlands within 0.5 mi of the site	4.9	12.4
		3.3.C Complements	Educational facilities or infrastructure on site?	Yes	Yes
		3.3.D Preferences	Will people prefer characteristics of the site?	Yes	Yes
	**Recreation**	3.2 How Many Benefit?	Number within 1/3 mi of the site	766	34
			Are there bike paths within 1/3 mi of site?	Yes	No
			Are there bus stops within 1/3 mi of site?	Yes	Yes
			Number within 0 to 0.5 mi of site	786	90
			Number within 0.5 to 6 mi of site	102481	35734
		3.3.A Service Quality	Total area of green space around site	45.1	48433
		3.3.B Scarcity	green space within 2/3 mi of site	27.2	62.2
			green space within 1 mi of site	38	68.9
			green space within 12 mi of site	39.5	38.8
		3.3.C Complements	Infrastructure supporting recreational activities?	Yes	No
		3.3.D Preferences	Are there additional features on the site?	No	No
	**Bird Watching**	3.2 How Many Benefit?	Number within 0.2 mi of site	298	8
			Are there roads or trails within 0.2 mi of site?	Yes	Yes
		3.3.A Service Quality	Will the site support rare or unique species?	No	No
		3.3.B Scarcity	NA	NA	NA
		3.3.C Complements	Supporting infrastructure or habitat on site?	Yes	No
		3.3.D Preferences	Will people be interested in birds at the site?	Yes	Yes
		3.4 Social Equity	Score	11.03	18.65
		3.5 Reliability	Score	15.2	58.4

BLACK = No entry; GRAY = NA; BLUE = Above Average/YES*; RED = Below Average/No* (*reverse for scarcity)


Photo by: Rick McKinney

Step 5: Use the Results in Decision Making

Question addressed in this step:

- Which site(s) to restore?

What does this step do?

This step evaluates the information you have gathered to make a decision. There are many ways to make decisions using this type of information, and we discuss some of them here. A full presentation of decision-making methods is beyond the scope of this Guide.

Applying this step:

You now have a picture of the important ecosystem services related to your decision, and the benefits the different restoration sites may provide. Sites are likely to provide different mixes of benefits, and a quick look at the indicators for each site will show where tradeoffs are likely to be important. Tradeoffs will be important when prioritizing sites for attention, choosing to restore to emphasize a particular benefit, or making other choices that require allocating resources.

Various types of tradeoffs may emerge across sites, including tradeoffs:

- Across sites for a single indicator
- Between indicators within an indicator category
- Between indicator categories for a single benefit
- Between benefit categories
- Among the groups of people who benefit

While this approach makes the tradeoffs apparent (information in red or blue on the summary sheet, as shown in Step 4), it does not explicitly include a method for evaluating tradeoffs based on people's values, which requires information on how different benefits are valued by the relevant groups of affected people. There are various ways to evaluate such tradeoffs, including:

- Using the indicators as a basis for discussion among stakeholders.
- Using the indicators in a more structured decision-making process that aims to prioritize sites using, for example, methods for multi-criteria decision analysis (Belton and Stewart 2002).
- Using the indicators as part of a monetary evaluation that applies dollar values from other contexts (i.e., benefit transfer). The indicators can be used to adjust existing monetary values to be more relevant to the local area, and to determine how many people benefit when applying per-person values to a change in an ecosystem service.

In some cases, the results may not be used for an actual decision, but instead to provide information to the public, funders, or others regarding what is being or has been accomplished by a particular project. In these cases information that does not vary across sites (appears in gray on the summary sheet) is still relevant.

Step 5 in Action—Use the Results in Decision Making

Here, we present examples of the different types of tradeoffs and how you might approach them.

Making tradeoffs across sites for a single indicator:
Comparing sites based on a single indicator can rely on the color-coding from Step 4. For example, service quality for flood risk reduction is much better at Site 448 than Greystone.

Making tradeoffs between indicators within an indicator category:
For recreation, the Greystone site has more people who benefit for all distances evaluated.

When comparing potential restoration sites based on how many people benefit, the number of people or homes in all distances will often be greater for one of the sites, as it is in this example. However, if this is not the case, people can be added up based on the reduced likelihood and/or reduced value of benefits for people farther away, using a lower weight for the people at greater distances. For example, for scenic views, Holzinger (2014) accounted for visibility at different distances using weights of 70 % and 30 % for his 50 meter and 100 meter distances, respectively. These weights account for the reduced probability that people will be able to see the site. In some cases, a greater distance also reduces the value of benefits received. For recreation, the percent of people within 1/2 mile from the site who will recreate at the site will be higher than the percent of the people from 1/2 mile to 6 miles from the site. In addition to this decrease in use, when people have to travel farther their cost to recreate increases, meaning their total benefit decreases.

Making tradeoffs among indicator categories for a single benefit:
For flood risk reduction, the Greystone site has more people who benefit and wetlands are more scarce, but site #448 has higher service quality.

These types of tradeoffs require that you weigh the importance of different indicator categories, based on importance of the different factors to the relevant populations (the people who benefit, funders, or others with a stake in the decision).

Making tradeoffs among benefit categories:
Hypothetically, if bird watching benefits from site #448 were better, but Scenic View Benefits from the Greystone site were better, a tradeoff would have to be made between benefit categories. As with tradeoffs among indicator categories, this requires weighing the importance of different benefits to the relevant stakeholders.

Making tradeoffs among the groups of people who benefit:
For flood risk reduction, the Greystone site potentially benefits people with social equity characteristics that make them more vulnerable to flood risks. This is based on the higher social vulnerability index score for people surrounding this site compared to the score for site #448.

In summary, there are many ways to use the indicators for decision making. Because the results are left disaggregated, to create a single score for each site, you will need to weigh each of the factors and aggregate them. Alternatively, keep the numbers in disaggregated form and use them as the basis for discussion among stakeholders, to determine which site is preferred overall.

In our example, summarized in Step 4, based on the blue-shaded results, the Greystone site, although it is much smaller, has many factors that indicate a high level of benefits for most of the services evaluated.

Tips from the Field:

Successful implementation tips from experienced managers

Even restoration projects with many benefits and people who would benefit sometimes do not make it down the long road to completion. To better understand the social factors that influence restoration implementation, we interviewed restoration managers involved in a suite of aquatic restoration projects in Rhode Island. Here are some of the **barriers** they encountered when doing restoration projects and some of the **strategies** they employed to overcome those barriers.

Unseen or Trashed Ecosystems

People often think urban systems are **too far gone**, there is **no nature in the city**, or that **contamination** makes restoration impossible.

- **Make systems visible**. Remove visual barriers to water or wetlands or organize outings to take people to see systems.
- **Shift perception of urban ecosystems.** There's a growing understanding of the value of urban ecosystems, particularly of their benefits to people. Make sure to communicate these benefits.

Resistance to Change

Even if there is general support for restoration, there may be resistance to change locally.

- **Don't assume** people are on board.
- Realize that public resistance does not necessarily mean ignorance of the benefits of the projects. Instead, there may be **concerns** about the project, prioritization of **different ecosystem benefits**, or **lack of trust** in some of the players.
- Make sure **lines of communication are open** to get to the bottom of the resistance.

Lack of Political Will

There is often a lack of political will for urban restoration both within the political system and within communities themselves.

- **Capitalize on events**, such as **natural disasters**, when the community may be primed to address watershed issues.
- Mobilize **visionary leaders.**
- **Build capacity** for change within communities.
- Invest in **long term engagement** with people and sites (see Public Engagement page for more ideas).

Funding Constraints

Urban projects can be expensive so there may be a lack of available funds. Also there may be a lack of capacity for spending, restrictions on funding, and inequity of distribution.

- Identify and communicate to the public and potential funders the **many benefits and people to benefit from** your project.
- Identify possibilities to address **environmental justice** issues. Programs and funding sources are primed to address these issues, and the results will have cascading benefits in the community.

The RBI step-by-step process ends here

This wraps up the explanation of the RBI Approach. Look back at past steps to review, or continue forward to the Glossary, Key Resources, and Appendices.

Photo by: Rick McKinney

Glossary*

Benefits: The things that people value, qualities that influence value, the ways people appreciate the things an ecosystem produces.

Beneficiaries: The people who benefit from ecosystem services.

Ecological Benefit or Economic Benefit or Social Benefit: In the context of environmental policy and management, the term applies specifically to net improvements in social welfare that result from changes in the quantity or quality of ecosystem goods and services attributable to policy or environmental decisions. Synonymous with "ecosystem-derived benefits" as used in Wainger and Boyd (2009) (modified from USEPA 2006).

Benefit Indicator: A non-monetary measure based on economic theory and empirical evidence of value that indicates a relative magnitude of value for ecosystem services.

Co-benefit: An ancillary (or off-target) benefit that is produced as a result of an action taken to produce a different benefit.

Complementary Goods and Services: Inputs (usually built infrastructure or location characteristics) that allow an ecosystem good or service to be used by complementing the ecological condition. For example, complementary goods and services that allow a population of fish to become the ecosystem service of "fishable fish," and thus to provide an opportunity for recreational fishing will include aspects of site accessibility, such as road access, available parking and the presence of a fishing pier, all of which make fishing at the site possible and may enhance enjoyment of the activity.

Demand: Generally, the amount of a particular good or service that a consumer or group of consumers will want to purchase at a given price. The level of demand for a good or service is determined by many different factors other than price, such as the availability and price of substitute and complementary goods and services. Along with supply, demand is one of the two key determinants of market prices. Since most ecosystem services are not bought and sold in markets, they are often not priced, and quantity demanded may not be readily observable. People may reveal their demand and value for non-market goods and services through their actions, or may express demand and value in responses to surveys.

Disservices: Adverse or unwanted outcomes of ecosystem functions and processes.

Ecological Output: A biophysical feature, quantity or quality that requires little further translation to make clear its relevance to human well being (i.e., a "public-friendly" measurement or valued attribute of the ecosystem). As such, ecological outputs are the key metrics for evaluating ES. For example, the abundance of watchable birds at a site is an ecological output that, when combined with complementary inputs such as transportation infrastructure, binoculars, and demand by birders, becomes an ecosystem service that produces the valued experience of recreational bird watching (adapted from: Boyd 2007; Boyd and Banzhaf 2007; Boyd and Krupnick 2009; Wainger and Boyd 2009; Wainger and Mazzotta 2011; see Ringold et al. 2009 for examples associated with streams).

Ecological Production Function: A description of the type, quantity and interactions of natural features required to generate measurable ecological outputs. For a simple example, the biophysical characteristics of a coastal wetland (flooding regimes, salinity, nutrient concentrations, plant species abundance, prey and predator abundances, etc.) can influence the welfare-enhancing output of increased abundance of a population of watchable wading shorebirds (the ecological output) (adapted from Wainger and Boyd 2009; Wainger and Mazzotta 2011).

Ecosystem Goods and Services: Outputs of ecological processes that directly ("**final ecosystem service**" sensu Boyd and Banzhaf 2007) or indirectly ("**intermediate ecosystem service**") contribute to social welfare. Some outputs may be bought and sold, but most are not marketed. Often abbreviated as ecosystem services (modified from USEPA 2006). The natural world supports and enriches people's lives in many ways; final ecosystem goods and services are end-products of nature, not the

*For additional terminology definitions, see Munns, et. al. (2015).

functions and processes of the ecosystem; to exist, *they require appreciation by people*. Many ecosystem services rely on more than one function, and many functions contribute to more than one service.

Ecosystem Structure: The abiotic and biotic components of an ecosystem.

Ecosystem Function: The physical, chemical, and biological interactions or processes within the ecosystem. Ecosystem functions are the processes of ecosystems that can provide valued goods and services; but functions exist regardless of whether people interact with, know about, or care about them.

Natural Restoration: The reconstitution of a pre-existing ecological condition, or range of conditions typically through physical site manipulations, vegetative plantings, and system management.

Non-market Value: The economic value of goods or services that are not bought or sold in markets.

Non-monetary Value: A measure of economic value that does not use dollars as the metric, but instead captures important aspects of economic value using other qualitative or quantitative metrics.

Nonuse Value: The value people hold for a service that they do not use in any tangible way. Sometimes referred to as "passive use value." Early literature in environmental economics split nonuse value into three components: existence value, option value and bequest value. Nonuse values are theoretically distinct from use values, although the boundary between use and nonuse values is often fuzzy.

Reliability: A measure of the likelihood that a site will continue to provide services and benefits over time, in the face of stressors.

Risk-aversion: A measure of a person's willingness to accept risk. A more risk-averse person will accept a lower level of risk than a less risk-averse person.

Stakeholder: Generally, an individual, group or organization with an interest in, or potentially impacted by, the outcome of a policy or management choice.

Substitute Goods and Services: Goods or services that can be substituted for a particular good or service, to fulfill the same or similar function. For example, similar sites may serve as substitutes for a particular recreational use; or technological solutions, such as water purification systems, may serve as substitutes for purification of water by forests.

Supply: Generally, the total amount of a good or service available for purchase (or use for nonmarket goods and services). Along with demand, supply is one of the two key determinants of market prices.

Total Economic Value (TEV): The sum of all relevant use values and nonuse values for ecosystem goods and services resulting from a change in a given ecosystem (i.e., the full social benefits). This is distinct from the asset value (sometimes referred to as "total value") of an entire ecosystem (e.g., the value of an entire wetland). Instead, it is the total value of a marginal change to that ecosystem.

Tradeoff: Generally, an exchange of one thing in return for another, especially relinquishment of one benefit or advantage for another. In a decision-making context, goods and services (including but not limited to ecosystem goods and services) gained or lost as the result of a management choice.

Uncertainty: A limit to knowledge where it is impossible to describe an existing state or future outcome exactly. Uncertainty has three primary components: 1) variability (also called "heterogeneity" or "stochasticity"), a component of all biological systems, which represents actual differences in the value of a parameter or attribute among units in a (statistical) population; 2) ignorance, which represents a lack of knowledge about the true value of a parameter that can result from inadequate or imperfect measurement; and 3) error, which results from the use of the wrong methods, models or data in analysis activities (derived from Munns 2002).

Use Value: The value of a good or service derived from its direct or indirect use (as opposed to nonuse value).

Valuation: Estimation of the worth, merit, or desirability of something assessed in terms of how much of one good or service a person is willing to give up to gain more of another good or service. It can be expressed quantitatively (for example, in monetary terms) or qualitatively.

Key Resources for More Information

The following references are recommended for additional information.

Our companion publications:

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Step	Question/Category	User Entries	
1	**Describe the decision context for**		
1.A	What are the main objectives of the assessment?		
	Are some objectives more important than others, or are there additional important objectives? If so, specify.		
1.B	What is the geographic scope for the decision?		
1.C	Who are the affected members of the public or stakeholder groups?		
1.D	Are there important stakeholder or public needs or wants? Are there any conflicting needs/wants?		
1.E	Is a rapid assessment sufficient?	○ Yes ○ No	
1.F	Number of sites		
1.G	Site names or identifiers		
1.H	Is there any additional information important to framing the decision?		

Step	Question/Category		
2	**Select Ecosystem Services and Describe Benefits for**		
2.A	Which Ecosystem Services are most relevant to the decision? What Benefits of the selected services are relevant to the decision?	☐ Flood Water Regulation ☐ Scenic Landscapes ☐ Learning Opportunities ☐ Reduced Flood Risk ☐ Scenic Views ☐ Environmental Education	☐ Recreational Opportunities ☐ Birds ☐ Other () ☐ Recreation ☐ Bird Watching ☐ Other ()
2.B	**Benefit Name** Provide background information on each service and the benefits being assessed.		
2.C	Provide background information on the concerns and disservices that may relate to the services and benefits being assessed.		
2.D	How do services and people interact geographically?		

Step	Question/Category	User Entries	
3	**Compile Benefit Indicators for**		
	Site name or identifier		
3.1	**A. Is there evidence of demand for the service?**	○ Yes ○ No	○ Yes ○ No
	B. Are any necessary thresholds of quality or quantity met?	○ Yes ○ No	○ Yes ○ No
	C. Are required complementary inputs available?	○ Yes ○ No ○ NA	○ Yes ○ No ○ NA
3.2	**How many people benefit?**		
3.3	**A. Quality of Service**		
	B. Substitutes and Scarcity		
	C. Complements		
	D. Preferences		

Step	Question/Category	User Entries	
3	**Compile Benefit Indicators for**		
	Site name or identifier		
3.1	**A. Has/will flooding occured/occur downstream of the site?**	○ Yes ○ No	○ Yes ○ No
	B. Can the site retain water that otherwise flows into the floodplain?	○ Yes ○ No	○ Yes ○ No
	C. Flood reduction benefits do not require Complementary Inputs (NA)	○ Yes ○ No ○ NA	○ Yes ○ No ○ NA
3.2	**1. How many people or homes are in flood zones and 0-2.5 miles downstream of the site?**		
3.3	**A.1 How large is the restoration site?**		
	A.2 Does the site contain additional features that may increase the site's retention volume?	○ Yes ○ No	○ Yes ○ No
	Note the additional features		
	B.1 Are there any substitutes (dams, levees, etc.) between the site and people who benefit?	○ Yes ○ No	○ Yes ○ No
	Note the substitutes		
	B.2 How many (number or percent cover) existing wetlands are within a 5-mile radius of the site?		
	C. Flood reduction benefits do not have Complementary Inputs (NA)		
	D. Are people who may benefit aware of and concerned about flood risk in their location?	○ Yes ○ No	○ Yes ○ No

Step	Question/Category	User Entries	
3	**Compile Benefit Indicators for**		
	Site name or identifier		
3.1	**A. Is the site visible from homes, roads or trails?**	○ Yes ○ No	○ Yes ○ No
	B. Will the site improve the scenic quality of the landscape?	○ Yes ○ No	○ Yes ○ No
	C. Scenic View benefits do not require Complementary Inputs (NA)	○ Yes ○ No ○ NA	○ Yes ○ No ○ NA
3.2	**1. How many people or homes within 160 feet of the site?**		
	2. How many people or homes within 160-325 feet of the site?		
	3. Do trails or roads pass within 325 feet of the site?	○ Yes ○ No	○ Yes ○ No
3.3	**A.1 Does the site have features or characteristics of aesthetic interest?**	○ Yes ○ No	○ Yes ○ No
	Note the features or characteristics		
	B. How much wetlands and open water are within 650 feet of the site (number or percent cover)?		
	C. How many different natural land cover types are within 650 feet of the site? (number of types)		
	D. Does the site meet these people's visual preferences?	○ Yes ○ No	○ Yes ○ No

Step	Question/Category	User Entries	
3	**Compile Benefit Indicators for**		
	Site name or identifier		
3.1	**A. Do people want to participate in environmental education nearby?**	○ Yes ○ No	○ Yes ○ No
	B. Will the site support wildlife or features of educational interest?	○ Yes ○ No	○ Yes ○ No
	C. Educational benefits do not require Complementary Inputs (NA)	○ Yes ○ No ○ NA	○ Yes ○ No ○ NA
3.2	**Number of educational institutions within 0.25 miles of the site?**		
3.3	**A.1 Does the site have features/habitat/wildlife of educational interest?**	○ Yes ○ No	○ Yes ○ No
	Note the features, habitat or wildlife		
	B. How many other wetlands suitable for educational use are within 1/2 mile of the site?		
	C.1 Will the site have complementary infrastructure?	○ Yes ○ No	○ Yes ○ No
	Note what these infrastructure are and their number or density		
	D. Does the site have characteristics that make it preferable?	○ Yes ○ No	○ Yes ○ No

Step	Question/Category	User Entries	
3	**Compile Benefit Indicators for**		
	Site name or identifier		
3.1	**A. Do people want to do recreational activities that require wetlands?**	○ Yes ○ No	○ Yes ○ No
	B. Will the site support recreational activities?	○ Yes ○ No	○ Yes ○ No
	C. Will required Complementary Inputs be available at the site?	○ Yes ○ No	○ Yes ○ No
3.2	**1. How many people or homes within 1/3 mile of the site?**		
	2. Are there bike trails within 1/3 mile of the site?	○ Yes ○ No	○ Yes ○ No
	3. Are there bus stops within 1/3 mile of the site?	○ Yes ○ No	○ Yes ○ No
	4. How many people/homes within 1/3 to 1/2 mile of the site?		
	5. How many people/homes within 1/2 to 6 miles of the site?		
3.3	**A.1 What is the total area of green space around the restoration site?**		
	B.1 Substitute greenspace within 2/3 mile of the site? (number/area)		
	B.2 Substitute greenspace within 1 mile of the site? (number/area)		
	B.3 Substitute of greenspace within 12 miles of the site? (number/area)		
	C.1 Does the site have infrastructure that supports more activities?	○ Yes ○ No	○ Yes ○ No
	Note what these infrastructure are and list the additional recreational activities supported		
	D. Does the site have additional features that people prefer?	○ Yes ○ No	○ Yes ○ No
	Note what these features are		

Step	Question/Category	User Entries	
3	**Compile Benefit Indicators for**		
	Site name or identifier		
3.1	**A. Do people nearby want to see or hear birds?**	○ Yes ○ No	○ Yes ○ No
	B. Will the site support bird species of interest?	○ Yes ○ No	○ Yes ○ No
	C. Bird watching benefits do not require Complementary Inputs (NA)	○ Yes ○ No ○ NA	○ Yes ○ No ○ NA
3.2	**1. How many people or homes within 1/5 mile of the site?**		
	2. Do trails or roads pass within 1/5 mile of the site?	○ Yes ○ No	○ Yes ○ No
3.3	**A.1 Will the site support rare or unique species?**	○ Yes ○ No	○ Yes ○ No
	Note why, or the results of bird habitat/functional assessments		
	B. Bird watching benefits do not have substitutes and measuring scarcity is beyond the scope of a rapid assessment (NA)		
	C.1 Will the site have complementary infrastructure or habitat?	○ Yes ○ No	○ Yes ○ No
	Note what this infrastructure is and its density		
	D. Are people who may benefit expected to have above average interest in bird watching?	○ Yes ○ No	○ Yes ○ No

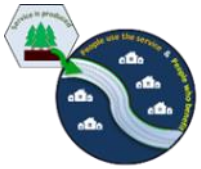
Step	Question/Category	User Entries	
3	**Compile Benefit Indicators for**		
	Site name or identifier		
3.4	**Social Equity (score)**		
	notes		
3.5	**Reliability (score)**		
	notes		

Appendix 1: The Checklist –Step 4 Summarize

	Step 4	Summarize the Indicators		Site	
	Benefit	**Indicators for**		**Site 1:**	**Site 2:**
	**Flood Risk**	3.2 How Many Benefit?	2.5 mi dow nstream of site and in flood zone		
		3.3.A Service Quality	Area of restoration site (acres)		
			Features that increase retention volume?		
		3.3.B Scarcity	Dams and levees 2.5 mi dow nstream?		
			Wetlands w ithin 5 mi (number or % area)		
		3.3.C Complements	NA	NA	NA
		3.3.D Preferences	Are people w orried about flood risk?		
	**Scenic Views**	3.2 How Many Benefit?	Number w ithin 160 ft of site		
			Number w ithin160- 325 ft of site		
			Weighted number w ho benefit		
			Are there roads or trails w ithin 325 ft of site?		
		3.3.A Service Quality	Aesthetic features or characteristics?		
		3.3.B Scarcity	Wetlands or w ater w ithin 650 ft (number or %)		
		3.3.C Complements	Natural land use types w ithin 650 ft (types)		
		3.3.D Preferences	Will people find it aesthetically pleasing?		
	**Environmental Education**	3.2 How Many Benefit?	Education institutions w ithin 0.25 mi of site		
		3.3.A Service Quality	Features/habitat/w ildlife of education interest?		
		3.3.B Scarcity	Wetlands w ithin 0.5 mi of the site		
		3.3.C Complements	Educational facilities or infrastructure on site?		
		3.3.D Preferences	Will people prefer characteristics of the site?		
	**Recreation**	3.2 How Many Benefit?	Number w ithin 1/3 mi of the site		
			Are there bike paths w ithin 1/3 mi of site?		
			Are there bus stops w ithin 1/3 mi of site?		
			Number w ithin 0 to 0.5 mi of site		
			Number w ithin 0.5 to 6 mi of site		
		3.3.A Service Quality	Total area of green space around site		
		3.3.B Scarcity	green space w ithin 2/3 mi of site		
			green space w ithin 1 mi of site		
			green space w ithin 12 mi of site		
		3.3.C Complements	Infrastructure supporting recreational activities?		
		3.3.D Preferences	Are there additional features on the site?		
	**Bird Watching**	3.2 How Many Benefit?	Number w ithin 0.2 mi of site		
			Are there roads or trails w ithin 0.2 mi of site?		
		3.3.A Service Quality	Will the site support rare or unique species?		
		3.3.B Scarcity	NA	NA	NA
		3.3.C Complements	Supporting infrastructure or habitat on site?		
		3.3.D Preferences	Will people be interested in birds at the site?		
		3.4 Social Equity	Score		
		3.5 Reliability	Score		

BLACK = No entry; GRAY = NA; BLUE = Above Average/YES*; RED = Below Average/No* (*reverse for scarcity)

Step	Question/Category	User Entries
1	**Describe the decision context for Woonasquatucket Example**	
1.A	**What are the main objectives of the assessment?**	We have a budget of $50,000 to spend on restoration in our watershed. We want to know which site or sites we can restore to provide the greatest benefits within this budget.
	Are some objectives more important than others, or are there additional important objectives? If so, specify.	We want to balance community benefits with ecological benefits.
1.B	**What is the geographic scope for the decision?**	The overall scope is the Woonasquatucket River Watershed. We have selected 2 sites to evaluate; the sites were proposed by local community groups.
1.C	**Who are the affected members of the public or stakeholder groups?**	In general, the people who live and work in the watershed. The communities near each of the sites are likely to be especially interested in their nearby site.
1.D	**Are there important stakeholder or public needs or wants? Are there any conflicting needs/wants?**	None have been identified upfront, but we will include the affected and interested people throughout the assessment and decision process.
1.E	**Is a rapid assessment sufficient?**	◉ Yes ○ No
1.F	**Number of sites**	2
1.G	**Site names or identifiers**	Site 1: Greystone Site 2: #448
1.H	**Is there any additional information important to framing the decision?**	We will evaluate feasibility of restoring each site and consider that in making the decision.

Step	Question/Category		
2	**Select Ecosystem Services and Describe Benefits for Woonasquatucket Example**		
2.A	**Which Ecosystem Services are most relevant to the decision?**	☑ Flood Water Regulation ☑ Scenic Landscapes ☑ Learning Opportunities	☑ Recreational Opportunities ☑ Birds ☐ Other ()
	What Benefits of the selected services are relevant to the decision?	☑ Reduced Flood Risk ☑ Scenic Views ☑ Environmental Education	☑ Recreation ☑ Bird Watching ☐ Other ()
2.B	**Benefit Name**	**Reduced Flood Risk**	**Scenic Views**
	Provide background information on each service and the benefits being assessed.	Wetlands retain water that would otherwise increase flooding, providing flood risk reduction benefits. We only consider reductions in flood risk to structures in the floodplain within 4 miles downstream.	Aesthetically pleasing landscapes provide observers with scenic views. We only consider views from homes or other structures.
2.C	**Provide background information on the concerns and disservices that may relate to the services and benefits being assessed.**	Water retained in wetlands may inundate areas directly surrounding the wetland or upstream, potentially causing flood damages in those areas.	Poor maintenance of a site may lead to accumulation of trash or overgrown vegetation, giving a "messy" appearance that people dislike.
2.D	**How do services and people interact geographically?**		

Environmental Education	**Recreation**	**Bird Watching**
Natural areas provide learning opportunities that lead to educational benefits. We only consider shorter less resource dependent educational visits of less than 1/2 day.	Wetlands provide opportunities for recreational activities, one of the main ways people interact with green spaces. We considered recreation generally and were more interested in everyday recreation, typically lasting a half day or less.	Wetlands provide the opportunity to view or interact with wildlife such as birds. We defined bird watching benefits as those provided to local residents, excluding serious birders who might travel from other areas to see birds.
There could be concerns about exposure during learning activities, such as sun, allergens and safety at the site.	Many of the disservices people associate with recreational sites have to do with user conflicts, which may arise when recreationists have different preferences.	People in urban areas may have negative attitudes toward specific bird species. It may be important to determine what these species are and explore their relationship with wetlands.
		

Step	Question/Category	User Entries	
3	**Compile Benefit Indicators for Woonasquatucket Example**		
	Site name or identifier	**Site 1: Greystone**	**Site 2: #448**
3.1	**A. Has/will flooding occured/occur downstream of the site?**	◉ Yes ○ No	◉ Yes ○ No
	B. Can the site retain water that otherwise flows into the floodplain?	◉ Yes ○ No	◉ Yes ○ No
	C. Flood reduction benefits do not require Complementary Inputs (NA)	○ Yes ○ No ◉ NA	○ Yes ○ No ◉ NA
3.2	**1. How many people or homes are in flood zones and 0-2.5 miles downstream of the site?**	20	6
3.3	**A.1 How large is the restoration site?**	0.54	3.84
	A.2 Does the site contain additional features that may increase the site's retention volume?	◉ Yes ○ No	◉ Yes ○ No
	Note the additional features	"Flood Abatement" probability 1 and 1.1 OES, for a score of 1.65	"Flood Abatement" probability 0.83 and 0.93 OES for score 1.86
	B.1 Are there any substitutes (dams, levees, etc.) between the site and people who benefit?	◉ Yes ○ No	◉ Yes ○ No
	Note the substitutes	3 Dams and 1 Levee	1 Dam
	B.2 How many (number or percent cover) existing wetlands are within a 5-mile radius of the site?	9.84	11.2
	C. Flood reduction benefits do not have Complementary Inputs (NA)		
	D. Are people who may benefit aware of and concerned about flood risk in their location?	◉ Yes ○ No	◉ Yes ○ No

Step	Question/Category	User Entries	
3	**Compile Benefit Indicators for Woonasquatucket Example**		
	Site name or identifier	**Site 1: Greystone**	**Site 2: #448**
3.1	**A. Is the site visible from homes, roads or trails?**	◉ Yes ○ No	○ Yes ◉ No
	B. Will the site improve the scenic quality of the landscape?	◉ Yes ○ No	◉ Yes ○ No
	C. Scenic View benefits do not require Complementary Inputs (NA)	○ Yes ○ No ◉ NA	○ Yes ○ No ◉ NA
3.2	**1. How many people or homes within 160 feet of the site?**	9	0
	2. How many people or homes within 160-325 feet of the site?	1	0
	3. Do trails or roads pass within 325 feet of the site?	◉ Yes ○ No	○ Yes ◉ No
3.3	**A.1 Does the site have features or characteristics of aesthetic interest?**	◉ Yes ○ No	○ Yes ○ No
	Note the features or characteristics	Based on Google Street View	
	B. How much wetlands and open water are within 650 feet of the site (number or percent cover)?	7.7	
	C. How many different natural land cover types are within 650 feet of the site? (number of types)	4	
	D. Does the site meet these people's visual preferences?	◉ Yes ○ No	○ Yes ○ No

Step	Question/Category	User Entries	
3	**Compile Benefit Indicators for Woonasquatucket Example**		
	Site name or identifier	**Site 1: Greystone**	**Site 2: #448**
3.1	**A. Do people want to participate in environmental education nearby?**	◉ Yes ○ No	◉ Yes ○ No
	B. Will the site support wildlife or features of educational interest?	◉ Yes ○ No	◉ Yes ○ No
	C. Educational benefits do not require Complementary Inputs (NA)	○ Yes ○ No ◉ NA	○ Yes ○ No ◉ NA
3.2	**Number of educational institutions within 0.25 miles of the site?**	2	0
3.3	**A.1 Does the site have features/habitat/wildlife of educational interest?**	◉ Yes ○ No	◉ Yes ○ No
	Note the features, habitat or wildlife	"Wildlife Habitat" probability of 0.43, and 0.53 OES for a score of 0	"Wildlife Habitat" probability of 0.71, and 0.81 OES for a score of 1.62
	B. How many other wetlands suitable for educational use are within 1/2 mile of the site?	4.9	12.4
	C.1 Will the site have complementary infrastructure?	◉ Yes ○ No	◉ Yes ○ No
	Note what these infrastructure are and their number or density	Assumed to receive signage after restoration	Assumed to receive signage after restoration
	D. Does the site have characteristics that make it preferable?	◉ Yes ○ No	◉ Yes ○ No

Step	Question/Category	User Entries	
3	**Compile Benefit Indicators for Woonasquatucket Example**		
	Site name or identifier	**Site 1: Greystone**	**Site 2: #448**
3.1	**A. Do people want to do recreational activities that require wetlands?**	◉ Yes ○ No	◉ Yes ○ No
	B. Will the site support recreational activities?	◉ Yes ○ No	◉ Yes ○ No
	C. Will required Complementary Inputs be available at the site?	○ Yes ○ No ◉ NA	○ Yes ○ No ◉ NA
3.2	**1. How many people or homes within 1/3 mile of the site?**	766	34
	2. Are there bike trails within 1/3 mile of the site?	◉ Yes ○ No	○ Yes ◉ No
	3. Are there bus stops within 1/3 mile of the site?	◉ Yes ○ No	◉ Yes ○ No
	4. How many people/homes within 1/3 to 1/2 mile of the site?	786	90
	5. How many people/homes within 1/2 to 6 miles of the site?	102481	35734
3.3	**A.1 What is the total area of green space around the restoration site?**	45.1	48432.9
	B.1 Substitute greenspace within 2/3 mile of the site? (number/area)	27.2	62.2
	B.2 Substitute greenspace within 1 mile of the site? (number/area)	38	68.9
	B.3 Substitute of greenspace within 12 miles of the site? (number/area)	39.5	38.8
	C.1 Does the site have infrastructure that supports more activities?	◉ Yes ○ No	○ Yes ◉ No
	Note what these infrastructure are and list the additional recreational activities supported	Outdoor Facilities -Yes (Cricket); Fishing /Boating Access-No; Bike paths-Yes (Biking); Trails-No	
	D. Does the site have additional features that people prefer?	○ Yes ◉ No	○ Yes ◉ No
	Note what these features are	No adjacent historic sites or scenic areas	No adjacent historic sites or scenic areas

Step	Question/Category	User Entries	
3	**Compile Benefit Indicators for Woonasquatucket Example**		
	Site name or identifier	**Site 1: Greystone**	**Site 2: #448**
3.1	**A. Do people nearby want to see or hear birds?**	◉ Yes ○ No	◉ Yes ○ No
	B. Will the site support bird species of interest?	◉ Yes ○ No	◉ Yes ○ No
	C. Bird watching benefits do not require Complementary Inputs (NA)	○ Yes ○ No ◉ NA	○ Yes ○ No ◉ NA
3.2	**1. How many people or homes within 1/5 mile of the site?**	298	8
	2. Do trails or roads pass within 1/5 mile of the site?	◉ Yes ○ No	◉ Yes ○ No
3.3	**A.1 Will the site support rare or unique species?**	◉ Yes ○ No	◉ Yes ○ No
	Note why, or the results of bird habitat/functional assessments		
	B. Bird watching benefits do not have substitutes and measuring scarcity is beyond the scope of a rapid assessment (NA)		
	C.1 Will the site have complementary infrastructure or habitat?	◉ Yes ○ No	○ Yes ◉ No
	Note what this infrastructure is and its density	From Statewide greenways plan	
	D. Are people who may benefit expected to have above average interest in bird watching?	◉ Yes ○ No	◉ Yes ○ No

Step	Question/Category	User Entries	
3	**Compile Benefit Indicators for Woonasquatucket Example**		
	Site name or identifier	**Site 1: Greystone**	**Site 2: #448**
3.4	**Social Equity (score)**	11.03	18.65
	notes	11.03 % High, 73.3 % Medium, 16.6 % Low, in 2.5 miles	18.65 % High, 81.3 % Low, in 2.5 miles
3.5	**Reliability (score)**	15.2	58.4
	notes	3.27 % Conservation & Limited, 5.56 % Parks & Open space, 6.34 % Water. From 2025 Landuse.	24.21 % Conservation & Limited, 8.45 % Parks & Open space, 18.16 % Reserve, 7.54 % water. From 2025 Landuse

Appendix 2: Example Application—Step 4 Summarize

	Step 4	Summarize the Indicators		Site	
	Benefit	**Indicators for Woonasquatucket Example**		**Site 1: Greystone**	**Site 2: #448**
	**Flood Risk**	3.2 How Many Benefit?	2.5 mi downstream of site and in flood zone	20	6
		3.3.A Service Quality	Area of restoration site (acres)	0.54	3.84
			Features that increase retention volume?	Yes	Yes
		3.3.B Scarcity	Dams and levees 2.5 mi downstream?	Yes	Yes
			Wetlands within 5 mi (number or % area)	9.84	11.2
		3.3.C Complements	NA	NA	NA
		3.3.D Preferences	Are people worried about flood risk?	Yes	Yes
	**Scenic Views**	3.2 How Many Benefit?	Number within 160 ft of site	9	0
			Number within160- 325 ft of site	1	0
			Weighted number who benefit	6.6	0
			Are there roads or trails within 325 ft of site?	No	No
		3.3.A Service Quality	Aesthetic features or characteristics?	Yes	
		3.3.B Scarcity	Wetlands or water within 650 ft (number or %)	7.7	
		3.3.C Complements	Natural land use types within 650 ft (types)	4	
		3.3.D Preferences	Will people find it aesthetically pleasing?	Yes	
	**Environmental Education**	3.2 How Many Benefit?	Education institutions within 0.25 mi of site	2	0
		3.3.A Service Quality	Features/habitat/wildlife of education interest?	Yes	Yes
		3.3.B Scarcity	Wetlands within 0.5 mi of the site	4.9	12.4
		3.3.C Complements	Educational facilities or infrastructure on site?	Yes	Yes
		3.3.D Preferences	Will people prefer characteristics of the site?	Yes	Yes
	**Recreation**	3.2 How Many Benefit?	Number within 1/3 mi of the site	766	34
			Are there bike paths within 1/3 mi of site?	Yes	No
			Are there bus stops within 1/3 mi of site?	Yes	Yes
			Number within 0 to 0.5 mi of site	786	90
			Number within 0.5 to 6 mi of site	102481	35734
		3.3.A Service Quality	Total area of green space around site	45.1	48433
		3.3.B Scarcity	green space within 2/3 mi of site	27.2	62.2
			green space within 1 mi of site	38	68.9
			green space within 12 mi of site	39.5	38.8
		3.3.C Complements	Infrastructure supporting recreational activities?	Yes	No
		3.3.D Preferences	Are there additional features on the site?	No	No
	**Bird Watching**	3.2 How Many Benefit?	Number within 0.2 mi of site	298	8
			Are there roads or trails within 0.2 mi of site?	Yes	Yes
		3.3.A Service Quality	Will the site support rare or unique species?	No	No
		3.3.B Scarcity	NA	NA	NA
		3.3.C Complements	Supporting infrastructure or habitat on site?	Yes	No
		3.3.D Preferences	Will people be interested in birds at the site?	Yes	Yes
		3.4 Social Equity	Score	11.03	18.65
		3.5 Reliability	Score	15.2	58.4

BLACK = No entry; GRAY = NA; BLUE = Above Average/YES*; RED = Below Average/No* (*reverse for scarcity)

Appendix 3: Wetland Bird Habitat Functional Assessment

Developed by Rick McKinney

In this Appendix we present an example of a custom-created functional assessment designed to be used with this benefits assessment approach. This functional assessment tool is specifically tailored to evaluate bird habitat in the Woonasquatucket and similar watersheds.

Photo by: USFWS National Digital Library

Overview

To aid in prioritizing urban land parcels for restoration, we developed a wetland habitat value assessment tool that can be applied using readily available internet resources. Information from two existing wetland wildlife evaluation models (Golet and Larson 1974, Golet 1976) were used to derive criteria to evaluate the potential of a parcel to provide habitat if restored to a wetland. The tool provides a strictly functional assessment, based on the ability of a parcel to provide wildlife habitat value after restoration. We used data and information about candidate parcels for restoration from the Woonasquatucket watershed, a mixed urban-natural watershed located near Providence, RI to develop the tool. While based on similar principles, our tool could be considered complementary to the wildlife habitat assessment component of a strategy for restoration of freshwater wetlands also modeled on data from the Woonasquatucket watershed (Miller and Golet 2001). We built our tool to assess the potential of a parcel to provide habitat for breeding birds: we focus on birds as an indicator species for wildlife habitat value because of their high visibility and positive impacts on the attitudes of urban residents (Bjerke and Ostdahl 2004, Luck et al. 2011), as well as the ready availability of field techniques and modeling approaches to describe their use of urban habitats. In addition, we selected ranking categories within the criteria to create an assessment geared to smaller, isolated wetlands more likely to be encountered in urban settings. These small wetlands, while not able to provide the extent of habitat represented by a larger wetland in a natural setting, may nonetheless have significant wildlife habitat value in the context of the urbanized landscape in which they are found. Hence our assessment attempts to capture habitat value that may be underestimated by assessments that are necessarily geared towards the full spectrum of freshwater wetland types and landscape settings.

Our assessment has two levels: the Office Assessment has 4 criteria designed to be evaluated remotely using readily available online information; the Office and Field Assessment adds two additional criteria that can be assessed using information collected during a visit to the site. The 4 criteria common to each assessment include parcel size, hydrologic connectivity of the parcel, landscape setting of the parcel, and the presence of adjacent natural habitats. The Office and Field Assessment adds criteria that incorporate the extent and distribution of vegetation within the parcel, and the presence of 4 habitat types that can support bird species of greatest conservation need.

To complete an assessment the user gathers the necessary information needed to assign the parcel of land being assessed to one of several categories within each criterion. The tool will use the assessment categories to calculate a numerical value for each criterion expressed as a percentage of the value of a parcel showing the maximum value for that criterion. The values can also be summed to produce an aggregate value for a parcel that could be used in a ranking for comparison of several parcels.

Basis for Assessment Criteria

Office assessment

The office-based assessment is comprised of four criteria designed to be completed using readily-available online data, such as Google Maps and associated tools. The four criteria are also included in the Office and Field Assessment. Below is a brief description of the scientific basis for development of each of the criteria.

1) Size class: This category reflects habitat value based on the size of the parcel, assuming upon completion of the restoration the parcel will be in some way functioning as wetland habitat. Freshwater wetlands in the northeast US vary in size from small, isolated seepage wetlands and vernal pools that can be well under one hectare in area, to expansive meadow marshes, forested wetlands, and bogs and fens that can extend for many hundreds or even thousands of hectares. In general, large wetlands are considered to be of greater value to wildlife as habitat, although smaller marshes also provide important habitat for endemic species or those with specific habitat requirements (Golet and Larson 1974). Several studies have reported a positive relationship between the number of bird species and wetland area (Brown and Dinsmore 1986, Craig and Beal 1992). These findings imply that larger wetlands may provide greater relative habitat value for some species of breeding birds. Larger and less fragmented wetlands may also provide greater habitat value to wildlife that are sensitive to human activities, since peripheral disturbances will have less of an effect on the inner part of the marsh (Golet and Larson 1974). Larger wetlands will also have less relative edge habitat per marsh area, which may mitigate processes such as nest predation that are often correlated with wetland edge (Johnson and Temple 1990). However, wetlands in general contain a greater diversity of habitat types, and are therefore more likely to meet all a species' habitat requirements than uplands or urban lands (Burke and Nol 1998). Therefore even very small or isolated wetlands in urban settings have value to birds, particularly as foraging habitat. Birds can take advantage of the greater diversity of plant and insect species found in urban wetland patches, versus upland or maintained areas. Our assessment acknowledges this by assigning value to even very small (e.g., less than 0.5 hectare) wetlands, while still reflecting the increasing habitat value associated with larger wetlands. We based our size categories on an analysis of the size range of existing parcels in the Woonasquatucket that have been proposed as candidates for restoration. Our assumption is that within the size range of candidate parcels found in the Woonasquatucket, habitat value will increase with increasing size. This is reflected in ascending point values (ranging from 1 to 5) for each size category from lowest to highest. When ranking a parcel we assigned size class a weight of 10 (i.e., the point value associated with the selected size category is multiplied by 10 before being included in the overall assessment ranking), based on our assumption that size of the wetland is of highest importance when determining its overall wildlife habitat value.

2) Wetland site type: The topography and hydrology of a wetland can influence its habitat value, and our assessment follows that of Golet and Larson (1974) by combining them into a single criterion, wetland site type. Wetlands in the northeast US can be found in the floodplain of a lake, pond, or stream, or in an upland setting. We also consider whether a wetland is hydrologically connected to a waterbody via surface water flow. In many cases floodplain wetlands are hydrologically connected, in general upland wetlands have a greater chance of being hydrologically isolated. Wetlands in floodplains are generally considered to have higher habitat value because of their enhanced productivity and plant species diversity resulting from the ready availability and frequently replenished supply of nutrients provided through exchange with the adjoining water body (Golet and Larson 1974). These wetlands may also benefit from periodic deposition of nutrient-rich soils during flooding events. On the other hand, isolated wetlands accumulate water primarily through surface water flow during precipitation events and groundwater seepage. This may result in lower

nutrient levels and also contribute to the ephemeral nature of these wetlands; their soils may dry during periods of low rainfall. These two factors in turn will act to decrease productivity and plant species diversity, resulting in decreased habitat value. The point values of our assessment categories attempt to capture the relative importance of wetland topography and hydrology to habitat value: point values range from 1 to 5 corresponding to categories floodplain / lakeside or deltaic (deltaic wetlands are found where a stream enters a lake), floodplain streamside, floodplain isolated, upland lakeside, and upland isolated. When ranking a parcel we assigned wetland site type a weight of 10 based on our assumption that the topography and hydrology of the wetland is of equal importance to size determining its overall wildlife habitat value.

3) Surrounding habitat type: This criterion reflects the landscape setting of the parcel, with a focus on land use within 1 km of the site. There are two potential mechanisms by which landscape setting can influence bird use of wetlands: by providing specific habitat for species who forage in wetlands but nest in the surrounding upland, and by influencing bird use of a site through human disturbance in areas adjacent to the site. The former is a generally positive effect that is most prevalent in the case of waterbirds; for example, many waterfowl species depend on the presence of specific habitat characteristics in the area immediately surrounding a wetland in order to successfully utilize the site. An example is the Wood Duck *Aix sponsa* that depends on the presence of nearby nest cavities in older trees, and hence would require mature forest around a site. The potential for human disturbance can be approximated by the extent of urban, agricultural, and maintained (e.g., recreational) land around a site. Many studies have noted the generally negative impact of adjacent urbanized land on bird abundance and community composition (e.g., Otis et al. 2013, McKinney and Paton 2009, McKinney et al. 2011). Adjacent agricultural land can have a negative effect on bird use of a wetland by replacing diverse natural areas with a monotypic habitat, but by providing a supplemental food source can also enhance use of a site some bird species (Dallimer et al. 2010, Marsden and Symes 2008). In our assessment tool surrounding natural land has the highest point value, reflecting the generally positive impact it has on bird use of a site. Urban land has the lowest point value based on its generally negative impact, and surrounding agricultural and maintained open (e.g., recreational areas) land are intermediate in value. We tried to capture the many possible variations in land use cover by making this criterion a continuous variable: the user enters the percentage of each land use category in a 1 km radius buffer surrounding a site, which is then used to derive an overall point value for the criterion. We assigned surrounding habitat type a weight of 8 given this criterion includes areas somewhat removed from the immediate vicinity of a site, and hence may have slightly diminished impact on a site's overall wildlife habitat value relative to size and site type.

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4) Scarcity (juxtaposition): In general, the presence of other parcels of natural land, or close proximity to a site of natural habitat types such as wetlands, will have a positive impact on a site's wildlife habitat value. The ecological justification for this lies in the assumption that a diversity of natural habitat types in a given area will result in both increased resource availability (e.g., more food, nest sites, shelter, water), and a greater variety of specific micro-habitats that could potentially support more species. Close proximity of other natural habitats will also allow for easier movement between habitat types (Golet and Larson 1974), and we acknowledge this by basing this assessment criterion on the number of habitats within a 1 km buffer of a site. There may be multiple discrete habitat types surrounding a site and those will enhance its habitat value regardless of their size; this is captured in the "number of associated habitats present" component of the criterion. Particularly in urban settings, we feel that even relatively small natural habitats

can have significant habitat value (McKinney et al. 2011). Regardless of the extent of nearby urbanization, even a relatively small number of adjacent discrete habitats can contribute to overall habitat value of a site if those areas comprise a significant portion of the area surrounding a site; this is captured in the "proportion of buffer (connectivity)" component of the criterion. Overall, extent of the surrounding landscape is given slightly more weight (6) versus the number of habitats (weight 5) when used in ranking habitat value of sites.

Office and field assessment

In addition to the above office-based criteria, the Office and Field Assessment adds two criteria requiring a field visit to the site to assess vegetation present and the extent of coverage and spatial orientation of vegetation of different vegetation classes. Below is a brief description of the scientific basis for development of each of the additional criteria.

5) Vegetation cover type: Cover type was developed for the assessment of waterfowl breeding wetlands in the north-central US prairie pothole region, in order to capture the relative amounts of vegetative cover and open water at a site (Golet 1976). The original intent was to identify ratios of vegetation to open water optimal for breeding waterfowl, based on the principle that areas with more water / vegetation interface, essentially greater shoreline extent, will have enhanced habitat value. We use cover type to assess the extent of water / vegetation interface, and also the extent of interface of edge between different vegetation types. The extent of interface will increase with greater interspersion between vegetation types, and also with greater irregularity of the interface between any two given vegetation types. A number of studies have demonstrated increased wetland bird abundance with increasing interspersion of vegetation types or, in the case of aquatic-dependent birds, with the extent of vegetation-water interspersion (e.g., Alexander and Hepp 2014, Bolenbaugh et al. 2011). In addition to open water, patches of vegetation should be considered when evaluating a potential restoration parcel using this criterion; vegetation types are those dominated by trees (woody plants greater than 3 m tall), shrubs (woody plants greater than 3 m tall), forbs (herbaceous flowering plants), and grasses. Interspersion among any of these vegetation types, or among any of these types and open water, should be considered when determining patterns of interspersion (i.e., peripheral bands of vegetation versus patches of vegetation). In the Office and Field Assessment vegetation cover type is given substantial weight (8), reflecting its importance in determining habitat use by bird species and hence its importance when ranking habitat value of sites.

5) Conservation of SGCN birds: This criterion assesses the ability of a restored parcel to provide habitat for a bird Species of Greatest Conservation Need (SGCN), and hence contribute to regional conservation of biodiversity. SGCN bird species are identified as part of the Rhode Island State Wildlife Action Plan (RIDEM 2015) as those species residing within the state that require actions to conserve to enhance their population status before they become threatened or endangered. We matched a previously-generated target list of bird species known to inhabit, or having a reasonable probability of inhabiting, the Woonasquatucket watershed (McKinney and Nightingale 2013) with the state SGCN list to identify the eight SGCN that are the focus of this criterion (Table 1). We then used key habitat requirements of these species to develop the components of the criteria. Most of the components of this criterion were weighted equally; however, a majority of the target SGCN species utilize early-successional or shrub habitat so parcels with greater than 50 % shrub habitat were weighted at twice the other components. Parcels with areas greater than 3 ha will allow for potential utilization by all target SGCN species; presence of dead trees will potentially allow for utilization by cavity nesting species, and multiple interspersed

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vegetation life forms (e.g., trees, shrubs, forbs) will also enhance the habitat suitability of the parcel for many species (Golet 1976). Overall, conservation of SGCN birds is the same weight as connectivity (6) when calculating its contribution to ranking habitat value of sites.

Specific instructions for using the wetland habitat value assessment tool

This section contains step-by-step instructions for completion of the data entry portion of the wetland habitat value assessment tool, which is located in the spreadsheet "Wetland Habitat Value Assessment Module.xlsx". Also included are suggestions for readily-available no-cost online tools to generate some of the data needed to complete the assessment.

Office assessment

1) Size class: to complete this assessment criterion the area of the parcel under consideration is measured, and entered in the data entry spreadsheet by placing an "x" in the appropriate cell corresponding to the range under which the measured area falls. A number of online tools or stand-alone programs can be used to estimate parcel area, one example is a readily-available third-party assessment tool developed for Google Maps (http://www.daftlogic.com/projects-google-maps-area-calculator-tool.htm). This tool allows the user to draw a polygon around a site and will provide the resultant area measurement.

2) Wetland site type: the geomorphic setting of the parcel can be determined by examining aerial imagery available online through programs such as Google Maps. Floodplain parcels are those that are located in close proximity to either a lake, pond, or stream and may be occasionally subject to inundation. Parcels located in floodplains of lakes or ponds and contiguous to the water surface, including those associated with streams as they enter a water body (i.e., deltaic), should be designated as "Floodplain lakeside; floodplain deltaic" and an "x" should be placed in the corresponding cell. Those located in floodplains of streams should be designated as "Floodplain streamside" and an "x" should be placed in the corresponding cell. "Floodplain isolated" are parcels that are located within the floodplain of a lake, pond, or stream but are not contiguous to the water surface. Upland parcels are those that are not located within the floodplain of a lake, pond, or stream; "Upland lakeside" parcels are located within 50 m of a lake or pond but, as a result of the topography of the landscape, would not be expected to be regularly flooded, while "Upland isolated" include all other parcels not falling within one of the four categories.

3) Surrounding habitat type: the landscape setting of a parcel is captured by quantifying the percentage of four general land use categories in a 1 km buffer around the parcel. Using any of a number of online tools or stand-alone programs (e.g., the assessment tool developed for Google Maps at http://www.daftlogic.com/projects-google-maps-area-calculator-tool.htm), the user draws a circle with a radius of 1 km centered on the parcel. The percentage of the various land use types are then estimated to the nearest whole number, and that number is entered in the corresponding cell for that land use type. For example, if one half of the area of the buffer around a parcel consists of urban land, with the remaining half equally divided between natural and maintained open land, one would enter 50 in the cell corresponding to Urban land, and 25 each in the cells corresponding to Natural land and Maintained open land. Maintained open land is vegetated land that is maintained as short grass habitat for recreational purposes, e.g., parks and sports fields, but can also include regularly mowed fields. Natural land includes all other vegetated areas (excluding maintained open land) and wetlands, lakes, ponds, and streams. Urban land includes residential and commercial areas, as well as those devoted to transportation and expansive areas of impervious surface. Agricultural land is cropland and areas used for livestock grazing. For more detailed descriptions of land use categories refer to the NLCD 92 Land Cover Class Definitions listed at the USGS Land Cover Institute (http://landcover.usgs.gov/classes.php).

4) Scarcity (juxtaposition): the presence of other parcels of natural land, or close proximity to a site of natural habitat types is assessed by examining aerial imagery of the area within the 1 km buffer drawn for the previous criterion. Count the number of discrete vegetated areas, i.e., forest patches, wetlands, lakes, or ponds, and place an "x" in the corresponding cell. For example, if two discrete forest patches and two wetlands are present within the buffer, place an "x" in the cell corresponding to "Moderate". Then estimate the percent of the total buffer area represented by the other parcels of natural land and place an "x" in the cell corresponding to the appropriate percent coverage.

Photo by: USFWS National Digital Library

Office and field assessment

The next two criteria will require a site visit to determine the presence and orientation of vegetation life forms at the site.

5) Vegetation cover type: a site visit, in addition to assessment of aerial imagery, is required to complete this criterion. Imagery is first used to determine whether any vegetation patterns present exist as discrete patches within the parcel, or in a peripheral band surrounding the site; e.g., a peripheral band of vegetation surrounding a stream of lake. A combination of a site visit and evaluation of imagery is then used to estimate the percent coverage of vegetation. With this information, select the category that best represents the spatial arrangement and percent coverage of vegetation within the parcel by placing an "x' in the corresponding cell.

5) Conservation of SGCN birds: this criterion requires a combination of office assessment of imagery and a site visit. Data from the size class assessment above can be used to determine parcel size; if greater than 3 ha enter an "x" in the appropriate box. Aerial imagery is used to determine the overall extent of vegetative cover of the site, estimated as an approximate percentage of the total parcel area. If greater than 30 %, a site visit is used to identify the vegetation life forms present at the site along with the approximate percentage of the total parcel area they each represent. If shrubs are present and comprise greater than 30 % of the total parcel area, enter an "x" in the appropriate box. Based on the field assessment of vegetation life forms present, determine whether there are at least interspersed life forms present and if so enter an "x" in the appropriate box. Finally, examine the site for the presence of dead trees or potential perch sites (usually limbs on dead trees), and if present enter an "x" in the appropriate box.

Accessing habitat prioritization scores

Once all the criteria have been ranked or scored, the module calculates a score for the parcel that is reported in either the 'Office Assessment Totals' or 'Office and Field Totals' worksheets of the module worksheet. The office assessment score is based on a total of 195 possible points and the totals are found in cells A20 through D26 of the 'Office Assessment Totals' worksheet; the office and field score is based on a total of 265 possible points and the totals are found in cells A26 through D34 of the 'Office and Field Totals' worksheet. Each totals section also calculates the percentage 'grade' for each criterion: a percentage 'grade' of 100 % would suggest that all of the potential habitat value for that criterion has been realized in the parcel. Interpretation and use of the scores is dependent on the goals of the assessment; for example, a series of parcels could be assessed and ranked in descending order based on total score, in which case a higher score would suggest enhanced habitat value. Parcels could also be ranked based on the score for a particular criterion if that criterion were of interest. Finally, any of the components of the assessment model (e.g., criteria weights, category scores) can be modified to fit a specific assessment goal.

Table 1. Selected habitat requirements of SGCN birds known to inhabit, or having a reasonable probability of inhabiting, the Woonasquatucket watershed.

Species[1]	Territory size (ha)	Preferred Prey	Key Habitat Requirements
Pileated Woodpecker	3.0	insects	downed wood and logs
Hairy Woodpecker	1.0	insects, fruit, seeds	live trees
Great Crested Flycatcher	2.5	insects	lepidoptera
Willow Flycatcher	1.0	insects	open perch sites
Least Flycatcher	0.2	insects	vertically heterogeneous vegetation layers
Gray Catbird	0.1	insects, fruit	shrub habitat
Eastern Bluebird	1.0	insects	open perch sites
Eastern Towhee	2.0	insects, fruit, seeds	well-developed leaf litter

[1]Scientific names: Pileated Woodpecker *Dryocopus pileatus*; Hairy Woodpecker *Picoides villosus*; Great Crested Flycatcher *Myiarchus crinitus*; Willow Flycatcher *Empidonax traillii*; Least Flycatcher *Empidonax minimus*; Gray Catbird *Dumetella carolinensis*; Eastern Bluebird *Sialia sialis*; Eastern Towhee *Pipilo erythrophthalmus*

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Appendix 4: Bird Habitat Assessment Checklist

Question/Category			User Entries							
Office		Site Name								
	Size Class	> 5.0 ha								
		2.6-5.0 ha								
		0.6-2.5 ha								
		0.1-0.5 ha								
		< 0.1 ha								
	Wetland Site Type	Floodplain lakeside; floodplain deltaic								
		Floodplain streamside								
		Floodplain isolated								
		Upland lakeside								
		Upland isolated								
	Surrounding Habitat	Natural Land								
		Agricultural Land								
		Maintained Open Land								
		Urban Land								
	Feasibility		Yes				No			
		Publically-owned	town- or state-owned land				private land			
		Currently vacant	no occupied dwellings or commercial establishments				occupied dwellings or commercial establishments			
		Accessible	opportunity for recreational use				no opportunity for recreational use			
		Evidence of contamination	site verified contaminanted or prior use suggests potential contamination				site verified clean or prior use suggests no contamination			
	Potential Benefit	1 km buffer around parcel > 80% residential								
		1 km buffer around parcel 50 - 80% residential								
		1 km buffer around parcel 20 - 49% residential								
		1 km buffer around parcel < 20% residential								
	Scarcity (juxtaposition)		High		Moderate		Low		None	
		Number of associated habitats present:	>5		3-5		1-2		0	
		Proportion of 1-km buffer around parcel (connectivity):	> 50% of 1-km buffer		25 - 50% of 1-km buffer		< 25% of 1-km buffer		0% of 1-km buffer	
Field	Vegetation Cover Type	76-100% Cover Plants	patches of vegetation							
		76-100% Cover Plants	peripheral band of vegetation							
		26 - 75% Cover Plants	patches of vegetation							
		26 - 75% Cover Plants	peripheral band of vegetation							
		< 25 Cover Plants	little to no vegetation							
	Conservation of SGCN	Dead trees or perch sites								
		> 30% shrub cover								
		3 or more interspersed vegetation life forms								
		Parcel area > 3 ha								

Appendix 5: List of Spatial Datasets

Short Name	Full Title	Scale
NLCD	National Land Use Cover Dataset	National
RI Land Use	Rhode Island Land Use and Land Cover 2011; rilo11b	Statewide
NWI	National Wetlands Inventory; NWI14	National
E-911 Roads	RI E-911 Road Centerlines; e911Roads13q2	Statewide
E-911 Addresses	RI E-911 Sites; e911Sites14r1	Statewide
Bike Paths	Bike Paths; bikepaths10	Statewide
SoVI	Social Vulnerability Index (SoVI) Census Tracts (2010)	National (Coastal)
2015 Projected Land Use	Land use 2025; landuse2025	Statewide
Bus Stops	RIPTA Bus Stops (January 2016); RIPTAstops0116	Statewide
State Recreation Facilities	State Comprehensive Outdoor Recreation Plan Inventory of Facilities; SCORP14	Statewide
Fishing and Boating Access	Fishing and Boating Access; fishBoatAcc12	Statewide
DEM Hiking Trails	RI DEM Hiking Trails; hikeTrails15	Statewide
Scenic Areas	RI Scenic Landscape Inventory; s44nsv89	Statewide
Historic Sites	Historic Sites of Rhode Island; s44chs99	Statewide
Schools	Schools; schools08.	Statewide

The following tools were also suggested as data sources for indicators in the example applications:

- EPA's EnviroAtlas: https://www.epa.gov/enviroatlas
- NOAA's coastal Flood Exposure Mapper: https://coast.noaa.gov/floodexposure/