A Method for Integrating Nature's Benefits into Land-use Decisions
Maritime Natural Infrastructure Collaborative
WITH APPENDICES

Prepared by: Nature NB
Updated Version 2.0; April 2018

Introduction

1.0 About the Maritime Natural Infrastructure Collaborative

Established in 2017, The Maritime Natural Infrastructure Collaborative (MNIC) is a multi-sector group of environmental practitioners, planners, and academics. The Collaborative works to support the integration of nature's benefits and services into land-use decisions in New

Brunswick, Nova Scotia, and Prince Edward Island. To date, the MNIC has engaged in various outreach/capacity building initiatives and have developed a simple methodology to support the integration of natural solutions into land-use and climate change adaptation planning. More information about the collaborative, ongoing projects and members can be found online at www.planwithnature.ca.

The MNIC would like to recognize the contribution of the following funders to our initiatives:

Environment and Climate Change Canada (Atlantic Ecosystems Initiative)
Government of New Brunswick (New Brunswick Environmental Trust Fund)

This document contains ten appendices which service to provide users with information and tools to implement the MNIC methodology. The appendices are listed here:

Appendix 1: Reviewed Reports – key documents reviewed in the development of the methodology
Appendix 2: Proposed Indicators/Thresholds for regulating, water-related ecosystem services
Appendix 3: GIS layers and important data useful for the methodology
Appendix 4: Question guides for community consultations and ground truthing
Appendix 5: Threats and services prioritization matrix
Appendix 6: Sample data sheet to organize Coarse Analysis
Appendix 7: Threshold conditions (proposed) for Step 2, Tier B
Appendix 8: Database of Ecosystem Service Modelling Tools (Step 2, Tier C)
Appendix 9: Best Management Practices for Ecosystem Services
Appendix 10: Best Management Practices Implementation Plan Sample

1.1 Project Background

Landuse decisions in Maritime Canada are primarily development driven, and tend not (with some exceptions) to recognize the various services provided by nature (e.g. flood risk reduction, water purification). Therefore, landuse decisions lead to actions that result in the deterioration of natural areas and the critical services they provide to our communities. These decisions also directly and indirectly impact human health and public safety through the deterioration of water quality and the risks that come with increased flooding.

Nature's services/benefits are commonly referred to as 'Ecosystem services'. Ecosystem services are the benefits people receive from nature and include a range of services ranging from clean water to fresh air to recreation. Considering ecosystem services in land-use decisions can help to identify cost-effective, efficient ways to help communities adapt to the impacts of climate change, such as increased flooding (Watson et al., 2016; Mourdrak et al., 2017). For example, the Intact Centre for Climate Change Adaptation recently studied the role wetlands can play in reducing flood risk in rural and urban centers in Ontario. The report

suggests that intact wetlands can help to reduce flooding during major storm events by 38% in rural areas, translating into significant economic savings in the form of reduced damages.

While high level approaches to landuse planning have been attempted (i.e. ecological land classification), the Maritime Natural Infrastructure Collaborative focuses on collaborative, grassroots solutions in an attempt to reduce the deterioration of ecosystems while addressing the challenges that inland flooding poses to human health and safety.

The methodology presented in this report provides various options for incorporating ecosystem services into planning and decision-making. We believe this toolkit will be useful for local governments, planners, NGOs, and others interested in advancing the use of ecosystem services in their communities. This methodology is collaborative in nature and will reviewed and updated regularly as time progresses. Any feedback, questions, or comments can be sent to Nature NB, the coordinator of the MNIC at climate@naturenb.ca.

Key Concepts

2.1 Ecosystem Services, Climate Change, and Landuse Planning

Ecosystem services: Ecosystem services (also referred to as Nature's Benefit or Nature's Value) are the benefits people receive from nature either as goods (e.g. wood, food, water) or services (e.g. carbon regulation, flood risk reduction). These services directly benefit communities and are commonly organized into four categories (MA, 2005). These include:

- Supporting services: (e.g. soil and water cycles)
- Provisioning services: (e.g. food, water, medicine)
- Regulating services: (e.g. flood risk reduction, erosion control)
- Cultural services: (e.g. recreation, well-being)

These services provide various environmental, social, and economic benefits to our communities. For example, a recent study has shown that a healthy floodplain/wetland complex upstream from the small community of Middlebury, Vermont, USA helped hold onto rainwater during a major Tropical Storm event in 2011, saving the town $1.8 million in avoided damages (Watson et al., 2016). While wetlands and riparian areas help reduce the severity of flood events, they also provide opportunities for recreation, clean water, and have intrinsic and cultural value (Brown et al., 2014).

Various activities can have a negative effect on the production and delivery of ecosystem services. These include:

- Development of natural areas (e.g. residential/commercial);
- Unsustainable use of resources;
- Climate change;
- Changes in nutrient load/pollutant sources;

- Impacts from invasive species (Boutler, 2011).

Without addressing these threats, we cannot expect to continue receiving the same level of service from nature (e.g. developed land cannot hold floodwater or filter drinking water).

Climate Change: With the onset of human-caused climate change, our communities will need to rely more heavily on nature's services provided by nature to remain safe and healthy. Climate change refers to changes in temperature, precipitation, and related patterns over a long time period. Human-caused climate change describes our current warming period and is different than previous warming periods. This difference is primarily due to the rapid warming that has been caused by human activities (e.g. fossil fuels, land conversion). Human-caused climate change is an important issue for the Maritime region as it is predicted to bring a variety of impacts that will impact our homes, health, and livelihoods. Some anticipated impacts include:

Inland flooding: More intense storms and melting periods will continue to damage critical infrastructure throughout the Maritimes. This means greater spending will be required for repairs. Inland flooding also damages personal homes and businesses and has direct impacts on our physical and mental health.

Rising temperatures: Increases in temperature pose significant health risks for vulnerable populations. These shifts may also affect our recreational and economic activities, such as agriculture, hunting, and fishing, as plants and animals are very sensitive to small changes in temperature/precipitation changes.

Increase in extreme storm events: Larger, more frequent snow, ice, and rain storms will continue to cause mass power outages, travel delays, and impact human health.

Forests, wetlands, and other natural areas can significantly reduce these impacts. For example, urban trees are able to provide shade during the summer months, reducing the impacts of rising temperatures. Wetlands also help to slow and hold onto water during major storm events, reducing the risk of inland flooding. Developing new strategies to protect and restore natural areas that provide these important services is critical if we hope to remain healthy and safe in the face of a changing climate.

Nature's benefits can be measured in a variety of ways. Unfortunately, many tools, mapping, and modelling approaches are inherently complex and require extensive knowledge/expertise. Thus, these may not be the best solutions for local governments and planners who may not have the time or capacity to prioritize these topics. As a result, the MNIC is exploring how to develop simpler tools that are informative and easy to apply at a local government scale.

2.2 Ecosystem Service Indicators

Indicators are a type of measurement used to provide information on the state/condition of a system. For example, various measurements, such as presence of particular plant and animal species, water chemistry, etc. have been used to indicate the health and/or function of ecosystems. In the context of ecosystem services, an agency may introduce wider vegetated buffer strips along rivers, streams, and wetlands to reduce flood risks and increase water quality. The success of this tool could be measured using indicators such as, water chemistry and/or volume of runoff before and after the buffers were developed. Indicators are useful in helping assess and communicate information about ecosystem service delivery, which can help inform policy and practice. While indicators are useful, there are challenges to their development and use. First, there is a lack of a consistent framework as well as data to develop and assess indicators (Brown et al., 2014; Boyd et al., 2015). In addition, there is limited information on what a "healthy" indicator condition is (e.g. how much forest cover is required to produce flood risk reduction service?). The MNIC has developed draft indicators that provide a starting point for measuring and using indicators when assessing ecosystem services in the Maritime context. More information is provided in *Step 2: Tier B* of this methodology and in Appendix 2.

2.3 Beneficiaries

Beneficiary groups as those who directly benefit from nature's services in a particular area. For example, a forested area may provide opportunities for recreation and can slow flood water during large storm events. The beneficiaries of this service are those who live near the forest (recreation) and those who live downstream and benefit from reduced flood damages during major storms.

As the previous example illustrates, a spatial relationship exists between the type of service provided and the groups that can benefit from it. As Mazzotta et al. (2016) describes, this spatial relationship can fall into one of three categories (see Figure 1). First, services can be produced in the same area they are delivered (e.g. a lake produces drinking water and recreation services to homes/wells around it). In the other two scenarios a service is produced at a particular location, while the benefit of the service either (b) occurs at various locations (people in all directions around a bird habitat can benefit by birdwatching), or (c) occurs in a specific direction away from the produced service (e.g. flood risk reduction service produced in a forest benefits those downstream from the source).

Figure 1: Spatial relationship between service production and beneficiary group (Source: Mazzotta et al., 2016)

This spatial relationship is important to consider as it provides information about which groups may be affected if a service is lost or compromised.

Ecosystem Service Modelling: Various geographic information systems (GIS) modelling tools exist to support the measurement, identification, and economic value of nature's benefits in the landscape. Some tools, such as iTree (itreetools.org) are focused on assessing the functions and benefits provided by specific ecosystem types. Others, such as InVEST assess where services are produced and flow at a variety of scales. While useful, these tools typically require a high level of GIS expertise and other skills.

InVEST was tested by the MNIC is pilot sites in New Brunswick and Nova Scotia. InVEST is a suite of modules that allow users to spatially represent how nature's services flow across the landscape. It is also a scenario planning tool that can be useful in exploring how changes in land-use could impact the flow of nature's benefits to beneficiaries. The tool has been used in various contexts including development permitting, climate change adaptation planning, and restoration planning. While useful, the MNIC has determined that InVEST requires a high level of capacity and expertise that is not always available in the local government context. As a result, the use of InVEST (and similar tools) has been categorized in *Step 2: Tier C* of the proposed methodology (see Step 2: Tier 3). For more information on InVEST visit naturalcapitalproject.org.

A list of prominent ecosystem service modelling tools can be found in Appendix 8. Local governments seeking to explore the possibility of incorporating nature's services into decision-making should explore what tools may be useful and practical to apply in their local context.

Chapter 3: Methodology

3.1 Overview of Methodology

This section will provide an overview of the methodology developed by the MNIC for integrating nature's services into land-use planning and decision. The methodology is aimed at helping local governments, decision-makers, and planners incorporate ecosystem services into decision-making. Through the use of this methodology, it is anticipated users will gain valuable knowledge about the location of ecosystem services, threats, and beneficiaries in their region. This information could be used to inform best management practices, future projects, and land-use decisions that protect or restore ecosystem services, rather than unintentionally degrade them. Aspects of this methodology were prepared and tested in pilot sites throughout New Brunswick, Nova Scotia, and Prince Edward Island.

The methodology is presented as a sequence of steps. If additional detail/context is required, users are invited to contact Nature NB at climate@naturenb.ca. The instructions assume that a site has already been selected for analysis (e.g. watershed/sub-watershed).

The methodology has four primary steps, which are presented in Figure 2. Each step will be described in detail below.

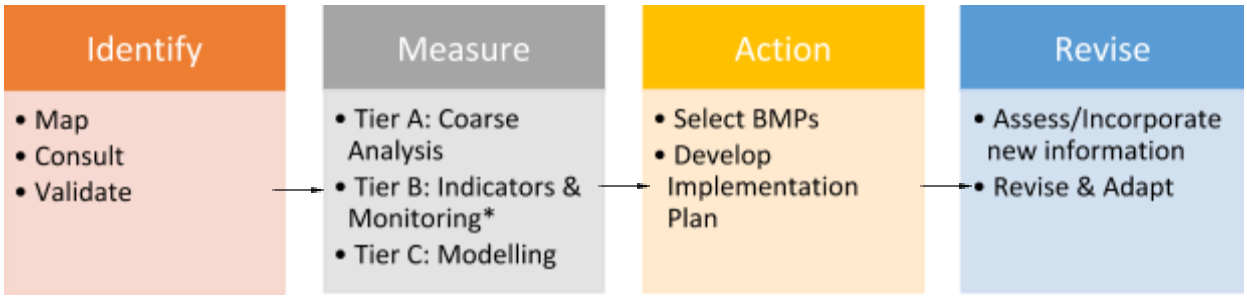
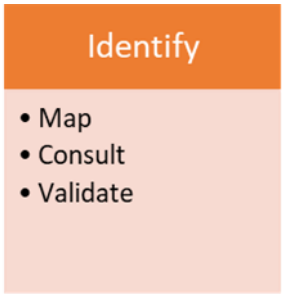


Figure 2: MNIC Methodology for Incorporating Ecosystem Services into Decision-Making. *Still in development.

3.2 Step 1: Identify



Goal: Users will identify services, threats, and beneficiary groups in the study site through community consultation and publically available GIS data.

Key Tools: Community Consultation Guide (Appendix 4); Data Layers Guide (Appendix 3); Groundtruthing Guide (Appendix 4)

Map

1. Prepare GIS of landuse/cover, ecologically significant sites, and other features (see Appendix 3 for recommended layers). Maps will form the foundation of ongoing discussions about the study site.

Consult

1. Organize 2+ meetings with environmental organizations, local knowledge holders, long-time residents, municipal partners, Indigenous groups, and others.
2. Record information from these groups about the important ecosystem services, threats, and beneficiaries in the area.
3. Integrate stakeholder consultation data into Sample Data Form. Include both spatial and non-spatial data/information.

Validate

1. Identify incorrect/missing data from the existing maps during consultations. For example, a watershed group may note that a deforested area on map is actually a wetland.
2. Where possible, conduct ground-truthing in portions of the watershed to ensure the accuracy of spatial data, identify additional threats/services, etc.
3. Record and digitize validated information, adjust layers, etc.

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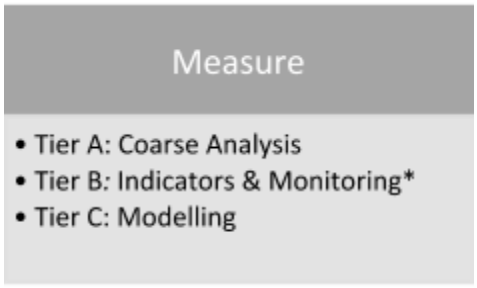
Step 2: Measure



Alternative tools (Tiers) accommodate users of varying levels of capacity. The Tier A methodology is the least onerous and could be pursued by any users with support from local environmental groups and stakeholders. Tier B and C require significant time/resources expertise as well as modeling/technical expertise. These Tiers can be pursued by users with advanced GIS capacity and sufficient staff time.

*Still in development

Tier A: Coarse Analysis

Goal: Spatially represent the various threats, challenges, and services in the study area. Identify priority areas where service delivery may be threatened and explore options for protecting/restoring services.

Key Tools: GIS/mapping reports (NB, NS, PEI); Consultation guides; Sample maps/Storymaps

1. Organize priority services and threats identified in Step 1 with stakeholders using the matrix provided in Appendix 5;
2. Collect relevant data layers and develop landscape unit GIS. *Note:* Landscape units may change depending on your region. Refer to Appendix 3 for data sources;
3. Identify key beneficiaries and record;
4. Map threats and services as separate layers, incorporate with landscape units
5. Prepare final maps (individual maps or StoryMap);
6. Analyze maps to determine where key threats are located and what services are impacted;
7. Generate list of priority areas/landscape units to be prioritized in *Step 3: Action.*

Outputs:

(1) Tabulated data from ecosystem service consultations (threats, services, beneficiaries)
(2) Maps that overlay ecosystem service information with landscape units
(3) Beneficiary group flowchart
(4) List of priority sites for *Step 3: Action*

Tier B: Indicators & Condition Monitoring *(In Development)*

Goal: Ecosystem service indicators are being refined by the MNIC to provide users with the opportunity to measure the level of service provided by particular landscape units. Tier B will also include threshold conditions that, if crossed, could mean the loss of a particular service. For example, if a watershed has less than 6% wetland area, wetland services may be compromised. Tier B will also provide an opportunity for users to explore the development of a condition monitoring program aimed at monitoring landscape units (e.g. wetlands, forests) to determine whether its health, and thus the services it delivers, are improving or degrading over time. Tier B builds off of Tier A and includes the following activities:

1. Assess landscape units based on the threshold conditions provided in Appendix 7;
2. Use threshold conditions (Appendix 7) to assess the condition of the mapped landscape units. Label landscape units Green (Healthy Service Delivery), Yellow (Reduced Service Delivery), or Red (Compromised Service Delivery). Where no threshold condition is cited, use expert opinion to select a threshold category;
3. Select relevant indicators that can be accurately measured over time (see Appendix 2).
4. Develop condition monitoring plan, based on the indicators, that can help track progress on the improvement in the health of the landscape unit, and by assumption the ecosystem services;
5. Use results in conjunction with results of Tier A to inform *Step 3: Action.*

Outputs

(1) Set of indicators and thresholds for different target landscape units/ecosystem services
(2) Condition Assessment of threshold conditions (Green, Yellow, Red)
(3) Condition Monitoring Plan* for assessing indicators over time based on the actions selected in *Step 3: Action**

*Tier B is still in development.

Tier C: Modelling

Goal: Provide general guidance/information for users with high technical and resource capacity to explore ecosystem service modelling tools. These tools can provide opportunities for: modelling the flow of ES, economic valuation, scenario planning, and understanding future impacts of land-use decisions (e.g. harvesting 30% of the forest in the watershed will result in X change in water flows). Tier C can be implemented following the completion of Tier A.

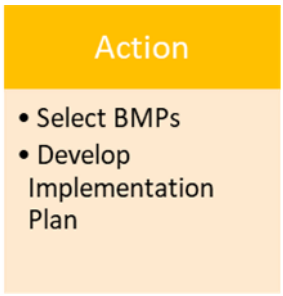
Steps:

1. Review Appendix 8 to determine what tools may be most useful and whether there is user capacity to implement modelling tools;
2. Select model/tool based on local needs and priority issues;
3. Collect data and execute model/tool based on user manuals;
4. Review results and use to inform *Step 3: Action*.

Outputs

(1) Maps with modelled ecosystem services, scenario planning tools, etc.
(2) Understanding of the value of certain ecosystem services on the landscape
(3) Updated list of threatened landscapes to be prioritized in Step 3: Action

Step 3: Action



Process

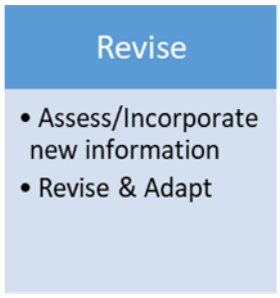
Goal: *Step 3: Action* uses the information collected on threatened landscape units to inform the selection of best management practices (BMPs) that could be used to retain and/or restore ecosystem services provided by these landscape units. A list of BMPs is provided in Appendix 9. This list includes planning, conservation, and restoration approaches and can be supplemented by information provided by the SERSC in their recent report "Planning the Blue Zone", see www.planwithnature.ca/planning-for-nature.ca for more information.

1. Based on prioritized landscape units/threats, review the planning approaches presented in Appendix 9.
2. Select relevant BMPs considering time, resource, and expertise capabilities. Consider land ownership and whether the BMP is a short, medium, or long term project.
3. Create a plan to implement selected BMPs into land-use planning/decision-making using the form provided in Appendix 10.
4. Consult with community members, stakeholders, and experts to ensure plan is realistic and can be implemented with existing resources (e.g. environmental organizations/consultants, planners, municipal staff, other local governments in the region, etc.).

Outcomes

(1) Completed list of selected, relevant BMPs, bylaws, etc. related to retaining or protecting key landscape units and their respective ecosystem services
(2) Implementation plan for the completion of BMPs and anticipated results

Step 4: Revise



Process

The MNIC recognizes that ecosystem service science and practice is in a rapid state of expansion with new information, reports, and tools being released regularly. As a result, the final step of the methodology asks users to assess and revise various information when using this approach to ensure new developments in the field are captured in your analysis.

For instance, LiDAR data may be released for a specific region, which could be incorporated to produce more accurate mapping of landscape units. This improved mapping may result in the need to conduct new consultations, outputs from ecosystem service models, etc. that could be used to improve the accuracy of knowledge about the services and threats a particular area is facing.

For regular updates on new tools, data, etc. refer to the MNIC website and sign up for our mailing list on www.planwithnature.ca.

Education and Awareness Building

The MNIC is engaged in education/outreach exercises to increase knowledge and awareness about the ecosystem services approach. To date, members of the collaborative have delivered presentations, workshops, and other communication tools to various audiences, including planners, municipalities, NGOs, and schools. Through the MNIC, any group or individual can access education materials (e.g. presentation templates, infographics, brochures) by contacting climate@naturenb.ca or 506-459-4209.

The MNIC has also prepared a report summarizing the key communication strategies that can be used by NGOs and other groups to introduce the concept of ecosystem services into their work. This report also includes a checklist for common messaging that has been proven to be effective when educating non-specialized audiences about the services provided by nature. Please visit www.planwithnature.ca/resources to view this report.

Next Steps and Future Work

As the MNIC efforts to integrate ecosystem services into decision-making continues, we are working to address some key challenges. Some of which include:

- Refining indicators and thresholds conditions (Tier B): Limited research and data exist on what standard indicators/thresholds for the characteristics of healthy, functioning ecosystems. The MNIC is working closely with experts in the field to identify these characteristics and develop simple, yet scientific, ways to measure and monitor the delivery of ecosystem services from our natural areas.
- Delivering outreach to municipalities: Greater efforts are needed to ensure local governments, planners, and other audiences have a baseline knowledge about the ecosystem service approach in order to ensure they understand its importance and are able to use the methodology outlined in this document.

Feedback:

We want to hear from you. Whether you are an NGO, local government, or planner interested in using the methodology, the MNIC is grateful for any feedback on our tools/methodology. As this work is structured to be open and collaborative document, all questions and feedback relating to this document will be carefully considered and incorporated into future versions. Please send direct feedback to climate@naturenb.ca or call 506-459-4209.

Appendices:

Appendix 1: Reviewed Reports/Frameworks

1. Value of Nature to Canadians Task Force. (2017). "Ecosystem Services Toolkit".
Source: http://publications.gc.ca/collections/collection_2017/eccc/En4-295-2016-eng.pdf

2. Open Standards for the Practice of Conservation
Source: http://cmp-openstandards.org/

3. The Environmental Law Institute. (2003). "Conservation thresholds for land use planners"
Source: https://www.eli.org/sites/default/files/eli-pubs/d13-04.pdf

4. Resiliency Alliance. (2010). Assessing Resiliency in Socio-Ecological Systems: A Workbook for Practitioners 2.0.
Source: https://www.resalliance.org/practice

5. Environment Canada (2013). How Much Habitat is Enough?
Source: https://www.ec.gc.ca/nature/default.asp?lang=En&n=E33B007C-1

6. Parks Canada Ecological Condition Monitoring

7. Naturally Resilient Communities
Source: http://www.nrcsolutions.org

8. Canadian Wildlife Service Habitat Conservation Strategies

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Version 4 - 2018

Appendix 2: Indicators/Thresholds (Draft)

Landscape Unit	Ecosystem Services (water related)	Indicator of Service (Is nature providing the service?)	Human Indicator (Can humans benefit from the service?)	Threshold Considerations (Very limited data - mostly related to buffer widths)	R S
Upland Forest	Water-flow regulation; Erosion/Nutrient regulation; Water purification	Water retention/infiltration capacity in soils; Peak flows; Number of flood events per year; Total forest area; Vegetation type and impact on hydrologic regime; Amount of soil retained Soil type/erodibility Slope angle/length Presence of vegetation Water quality indicators Comparison of pollutant concentrations between inflow and outflow Diameter to breast height (iTree selects sample sites);	Trails/paths in low impact areas (e.g. away from wetlands; riparian areas); Absence of infrastructure/activity in upland forest; Use of compatible forestry practices; Presence of homes/businesses in downstream area. Cost to replace services (shade, water regulation, etc.)	>10% impervious area results in habitat degradation/river channel instability; Water flow regulation: Maintain/develop vegetated buffer (20 - >100m along watercourses) Erosion reduction: 10m->100m vegetated buffer along watercourses Where slopes greater than 20%, the buffer increase 1m for each 2% of slope (maximum of 60m) Water infiltration 10-100 times greater under trees then in deforested landscape (Chandler et al., 2018) The choice of tree species may be less important than forest land use for mitigating the effects of surface runoff. (Chandler et al. (2018) 20% increase in flooding with every 10% deforested based on data from 56 developing countries (after controlling for rainfall, elevation, soil moisture) 50% forest cover helps maintain aquatic system health, reduce flashiness of flooding (EC, 2013) Water flow regulation: Maintain/develop vegetated buffer (20 - >100m along watercourses) Erosion reduction: 10m->100m vegetated buffer along watercourses	E (e a s m Ir (r .c iT (i G w c **S** e B (2 2 E 2 L B E 2 N T

Wetland	Water-flow regulation; Water purification; Erosion/nutrient regulation;	Water retention capacity of soils/surface Area coverage of natural/semi-natural wetland Floodplain water storage capacity Peak flows; Water quality indicators Maximum filtering capacity Water retention time; WESP-AC tools (see Appendix 8); Amount of soil retained Sediment captured Soil type	Avoided flood damages (development in downstream area) Number of days nearby water bodies unsuitable for purpose (swimming, drinking) Estimated replacement costs to replace natural water quality/flood risk reduction services Number of homes in area on wells/septic	>10% impervious area effects habitat degradation, river channel instability; >6% of wetlands needed in sub-watershed or 40% of historical coverage to perform general functions >9m buffer needed to ensure P and sediment removal (around wetlands) >30m buffer needed to ensure N removal service (around wetlands) >23m buffer needed to ensure groundwater protection (around wetlands) At-risk infrastructure 4km downstream from altered could be affected by increased flooding	
Rivers/ Streams	Water-flow regulation; Nutrient/ Erosion regulation	Water quality indicators; Number of in-stream barriers; Number of days' water is of insufficient quality Channelization	Avoided flood damages (e.g. presence of development downstream); Number of homes on wells/septic; Fishing areas	Locally defined water quality indicators (chemistry, temperature) NB Example: http://www2.gnb.ca/content/dam/gnb/Departments/h-s/pdf/en/HealthyEnvironments/DrinkingWaterGuidelines.pdf Water quantity: flow rate, water levels, peak flow graphs, etc.	

			relying on high quality habitat Number of days' nearby water bodies unsuitable swimming, drinking, etc.		
Riparian Area	Water-flow regulation Water purification Nutrient regulation Erosion regulation	Water retention capacity of soils/surface Floodplain water storage capacity Peak flows; Riparian area width along waterbody (m); Vegetation type and extent; Slope angle/length; Residence time of water	Avoided flood damages (e.g. presence of development downstream); Number of homes on wells/septic; Fishing areas/club relying on high quality habitat Number of days' nearby water bodies unsuitable swimming, drinking, etc. Cost to replace services (shade, water regulation, etc.)	Buffer widths: Nitrogen/Phosphorus retention: Vegetated buffer (20-100m along watercourses); Armouring or horizontal setbacks are ineffective Water flow regulation: Maintain/develop vegetated buffer (20 - >100m along watercourses) Erosion reduction: 10m->100m vegetated buffer Bank Stabilization: 10-52m vegetated buffer	R m **S** 2 E 2 L
Grassland	Water-flow regulation Erosion regulation Nutrient retention Water purification	Dominant land cover Water retention capacity of soils/surface Peak flows Water quality indicators	Avoided flood and damages Cost to replace soil nutrients from runoff Number of homes on wells/septic Fishing/hunting areas relying on high quality habitat	Grassland area can reduce 20% more runoff than cropland, which is 50% better than urban areas. Butler et al.(2008): greatest runoff volume from heavy-use plots and poorly drained soils vs. low-use, well drained (35 % vs. 12% of rainfall as runoff) Fertilization can reduce ground water recharge by 50 % (Rose et al. 2011).	

Cultural	Recreation / Tourism	Public access trails, parks, protected areas in area Presence of features with scientific/cultural value;	Investment in recreation activities; Tourism data; Presence of hunting/fishing/recreation club	20km radius from dwelling has been used as a measure for how far Canadians will travel for a day trip. This accounts for 73% of nature-based recreation; 49% of hunting and trapping; 54% of fishing.	V C 2 G (2

Appendix 3: List of GIS Layers for Consultation Maps / Landscape Unit Maps

Consultation Maps (Step 1)
The general data used to prepare consultation and Coarse Analysis maps in New Brunswick, Nova Scotia, and PEI is listed below. For specific layers used in each province and data sources please see Regional Reports. Some of the layers present will only be relevant in specific regions. This list is meant to be used as a guide for others interested in assessing ecosystem services in other regions.

Aerial/satellite imagery
Environmentally Sensitive Areas
Peat lands
Calcareous eco-sites (rare/high biodiversity area)
Hydrographic Network
Wetlands
Protected Wetlands and wellfields
Land cover
Depth to water table mapping
Forest
Forest Loss (Global Forest Watch)
Forest Canopy Height
Building Footprints
Aquatic Species/Rare Species Occurrences

Appendix 4: Question/Consultation Guides

Watershed Group/Local Experts Consultation – Data Validation

1. Are there natural assets that have a lot of meaning to people in this area/watershed? (e.g. significant commercial species, culturally significant area, etc.)

2. Are there natural assets that have a lot of meaning to people downstream of this watershed? (e.g. significant commercial species, culturally significant area, etc.)

3. If yes, what are they? How are they valued by people? Are these assets under threat by anything? (e.g. development, climate change, etc.)

4. Are there significant sites within these watersheds were recreation occurs? (e.g. hiking, climbing, etc.)

5. Is the land-use/land-cover layer accurate? Any changes you would recommend to add, alter, and/or remove?

6. Are there any areas within the pilot site that development may occur or has occurred? Any other threats?

7. Does this watershed currently experience any significant pressures from various sources (e.g. development, contamination or pollutants from industry/agriculture/aquaculture, dumping, etc.)

8. Can you describe historical changes in the protection, development, and use in the watershed area that may be of importance?

9. Is the general land-cover layer accurate? If not, what would you recommend to add, alter, and/or remove?

10. Are all the streams found in the watershed mapped? If not, where are others? Are some altered or have changed?

11. Are the forest classifications and areas accurate? If not, what would you recommend to add, alter, and/or remove?

12. Are you aware of areas that are wet/flooded during some parts of the year, but are not wetlands? If so, where are they on the map?

13. Based on your knowledge and work, are there other layers that you would add to the map if you were exploring the benefits provided by nature in this watershed?

14. Are there other local knowledge holders, stakeholders, etc. who are knowledgeable about the watershed that I should get in touch with?

15. To the best of your knowledge, are these coordinates for Ecologically Sensitive Areas accurate? (if relevant)

Question Guide for Community Consultations

Introduction for Participants: The goal of the meeting is to understand what types of habitats and features are on the landscape. In addition, we are interested in learning about possible threats (e.g. flooding areas, runoff) and benefits people receive from the area (e.g. drinking water, recreation trails). The information you provide will help us understand what areas are most important for wildlife, residents, and community groups in your area. No personal or private information will be shared in any way without your consent.

For Facilitators: The goal is to obtain information about nature's services, but also what threats face these areas and what people rely on nature for in the site. This consultation should be open to participant input and, as such, the questions below are meant to guide the conversation. Feel free to integrate your own questions in addition to the question guide.

Process:

1. Ask participants if they would verbally consent to being audio recorded;
2. Provide brief overview/key landmarks on the map to orient participants;
3. Work through question guide to guide conversation (and add your own questions)
4. If a specific site is discussed by participants be sure to mark the area on the map.

Question Guide:

- Do you hunt or fish in the area? If so, where? What type of wildlife do you see there?
- Are there any areas that are cut or cleared there recently that you have noticed? (e.g. old forest, clear-cut)
- Are there areas where you live or visit where flooding has occurred? Do you know what has caused this flooding (e.g. log/ice jams, river flooding, etc.)?
- Do you know of any beaver activity in the area? If so, where are they located?
- Have you noticed any activities on the land that concern you?
- Have you noticed any issues, such as runoff into streams/rivers, which may harm fish and wildlife in the area? Where? Garbage dumping?
- Do you harvest timber and/or non-timber products (e.g. fiddleheads) from the land? If so, where generally?
- What types of forest do you see in these areas? (e.g. conifers, mixed woods, etc.)?
- Do you or others hike or ski on the land? ATV or snowmobile? If so, where do you spend time? Have you noticed any wildlife, cleared areas, flooding, or other threats?
- Have you seen or heard about flooding in the community or along roadways that has caused a lot of damage? Are there any areas in the community or along roadways that have had a lot of erosion? Do people rely on well water in this area?
- Where do resident's drinking water come from (e.g. wells, protected watershed area)?
- Are there any businesses/industries that operate in the area?

Groundtruthing Guide

Description: The purpose of the groundtruthing guide is to verify data and information using a basic process that can be easily replicated in the future. This type of groundtruthing will assist efforts by improving the precision of the data and the identification of threats, services, etc.

Size: The site should be within a portion of the previously mapped sub-watershed site. The site should be large enough to include different land cover/uses. (e.g. mapped wetlands, forests, streams/rivers, roads, development, and agriculture). It is recommended groups work along a tributary (river/stream) of the pilot site.

Characteristics: Ideally the site will have:

- A stream/river that is part of the sub-watershed system
- Forested area (including a stand that is >15 m, see legend on map for more detail)
- Local significance (e.g. area that has flooded or is under development pressure)
- Near roadways with culverts that could be measured
- Area that does not infringe on local property owners. Note: if travelling by navigable stream this is not an issue

Points of Interest: Important data to consider/collect:

Wetlands

Identify wetlands not currently mapped in the area

- **Record:** Approximate area or dimensions, GPS point, photo and any small inflows/outflows that may not be mapped

Vernal pools/seasonal wet areas

- **Record:** approximate length & width, GPS point, photo (*Guide for identifying vernal pools to be sent ASAP*)

Streams and riparian zones

Riparian zone integrity

- **Record:** Is it intact? Where has it been altered/removed? Why has it been altered/removed? (GPS point and photo)

Runoff

- **Record:** Any observation of runoff, etc. into waterways (GPS point and/or photo)
- **Record:** Source of runoff (e.g. pipe, impervious surface, agriculture, forestry, small stream)
- **Record:** Small streams that may not be mapped (GPS point, photo, approximate channel width)

Beaver Dams/Culverts

- **Record:** Presence of beaver dams and the approximate size of their ponds (GPS point, photo)
- **Record:** Size and characteristics of culverts (GPS point) *Additional measurements to be provided ASAP*

Forests and landscapes

For tree areas above 15 m (see legend on map)

- **Record:** From a single vantage point (provide GPS point and photo); % Deciduous vs. % Coniferous (record individual species, if possible)

Culturally significant areas

- **Record:** Locally significant/culturally significant sites that were not identified on previous maps (GPS point, photo)

Cleared areas

- **Record:** Any clear cuts not labelled on map (GPS point and photo) No need for exact size.

Additional Notes: Take various pictures and record GPS points. A tape measure or yardstick may be useful for measuring culverts and other small features. Large areas can be estimated by comparing it to something you know, such as a football field (for example this beaver pond is 1.5 football fields). We do not need exact measurements, estimates are fine.

Appendix 5: Sample Threats/Ecosystem Services Prioritization Matrix

Threat	Impact on Services	Service	Demand for Service	
Nutrient Loading	High	Water Quality	Very High	
Invasive Species	High	Recreation/parks	Very High	
Flooding	Medium	Recreation/fish	High	
Clear Cutting	Medium	Flood risk Reduction	Medium	
Threat to Service	**Water Quality**	**Flood Risk Reduction**	**Recreation/fish**	
Flooding	Low	Low	Low	
Clear Cutting	High	High	Low	
Nutrient Loading	Very High	Low	High	
Invasive Species	Low	Low	High	

Ranking Order
Threats:
• **Very High:** The threat is likely to be very widespread or pervasive in its scope, could eliminate habitat/service(s), and/or is not reversible;

• **High:** The direct threat is likely to be widespread in its scope, may cause serious degradation of habitat/service(s), and may be reversible, but not practically affordable;

• **Medium:** The direct threat is likely to be localized in its scope, may moderately degrade service(s), and could be reversed with a reasonable commitment of resources;

• **Low:** The direct threat is likely to be very localized in its scope, may slightly impair a service(s), and the effects are easily reversible at relative low cost).

Services:
• **Very High:** The service is likely to be very widespread and greatly benefits people in the area, if the service were to be removed there would be significant public health/safety consequences;
• **High:** The service is likely to be widespread in its benefits and is important to local community members, the service may be able to be replaced, but would cost an extensive amount of money and be of high costs to replace;
• **Medium:** The service is likely to be localized in its scope, may moderately benefit people, and could be replaced over time (naturally or artificially)
• **Low:** The service is likely to be very localized in its scope, and only slightly benefit people in the area due to lack of demand or supply, easy to replace.

Appendix 6: Example Data Sheet for Coarse Assessment

Site Name:	**Consultation Date(s):**

Threats:

ID	**Threat**	**Service Impacted**	**Location**	**Coordinates ?**	**Notes**
1	Deforestation	Various	Forest Loss Layer	Various	
2	Upstream Development	Flood risk reduction; water quality	Built up area	Various	
3	Nutrient Loading	Water quality			Gener
4	Waste	Water quality	SAS-14	See report	
5	Flooding		Weisner Rd.		Limite issue Easte the wa views proper
6	Ice Wash Outs	Flood risk reduction			
7	Riparian zone degradation	Flood reduction; water quality	SAS1-5; Irishtown	See report	
8	Erosion	Water quality; habitat	SAS 18-23; 38	See report	

Services

ID	**Landscape Unit**	**Service**	**Location**	**Coordinates**
S1	Wetlands / Riparian / Forest	Water Quality	Various	Well fields (see map)
S2	Forest	Forest Products	Various	
S3	Wetlands / Riparian / Forest	Flood risk reduction	Various	
S4	Forest	NTFP (maple, fiddlehead)	Various	
S5	Trails	Recreation	Mapped	
S6	Forest	Good canopy height; flood reduction	Groundtruthing area	See report
S7	Cultural Service	Hunting	N/A	N/A

Beneficiaries

ID	**Group**	**Notes**	**Indicators**	**Coordinates**
B1	Homeowners	Flood risk, well water	Homes/roads	Various
B2	Agriculture	Food / livestock	Fields/farms	Various
B3	Fishers/Hunters	No specific areas noted	Streams/rivers	NW Area (hunting)
B4	Recreation	ATV/Snow/Hike	Trails	Mapped
B5	Business	Forestry	Forest gain layer?	Mapped

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Version 4 - 2018

Appendix 7: *Units for Coarse Prioritization of Areas Susceptible to Loss of Flood Risk Reduction Services (Step 2; Tier B)*

Note: This part of the methodology is still in development. Threshold categories were calculated using a mean value (threshold condition) for Fair category, and a mean value +/- 80% for the Good/Poor category respectively (based on method used by Parks Canada, Ecological Integrity Monitoring Program).

Landscape Unit	Habitats Included	Services Provided	Threshold Conditions	
Upland forest	Hardwood forest Softwood forest Mixed-wood forest Regenerating clear-cut (loss of service)	Natural regulation of: water flow, erosion, climate (humidity, ground temperature); carbon storage	50% forest cover required to minimize flashiness of surface runoff events; 50% forest cover required for "healthy aquatic ecosystem function" (Environment Canada, 2013) 4%-28% increase in flood frequency and 4%-8% duration, with every 10% deforested (Bradshaw et al., 2007) ***Note:*** Softwoods will not retain moisture on the landscape as long as hardwoods	**Poor: <1 area** **Fair: 50% area** **Good: 90 forested**
Wetlands	Open water marshes Peatlands Forested swamps Vernal pools	Natural regulation of: water flow, climate, nutrient and sediment movements	>6% of watershed land mass OR 40% of historical coverage to maintain function (Environment Canada, 2013)	**Poor: <1 <8% hist coverag** **Fair: 6% historica** **Good: >1 >72% his coverag**
Riparian zones	Flood plain Steep sides of rivers	Natural regulation of: water flow, sediment movement	30 - >150 m vegetated buffer required for water flow regulation, erosion reduction, nitrogen/phosphorus retention (Environmental Law Institute, 2003) +0.61m per 1% slope (Environmental Law Institute, 2003)	**Poor: 16 width, <0 slope** **Fair: 30-3 width, +0 slope** **Good: 54 buffer wi +1.1m/1%**
Stream/Rivers	Streams & rivers above the head-of-tide Springs	Natural hydrology / regulation of water flow	# in-stream barriers to flow increase flood risk For example, blocked culverts, filled streams, log jams, etc.	**Poor: Ma large bar multiple**

			(specific numbers will depend on the system as no current guidance is available on in-stream barriers at the sub-watershed scale).	**jams) in streams/** **Fair: Few barriers streams/** **Good: Fe identifie culverts siltation)**
Barrens (Nova Scotia)	Limestone outcroppings; granitic bedrock, dense layers of ericaceous (heath) vegetation	Regulation of water flow; natural disturbance regime (fire)	% cover and proximity to development would be important metrics to consider (Neily et al., Ecological Land Classification for Nova Scotia, Report DNR 2005)	N/A
Grassland	Native grassland Livestock pasture Perennial crops (hay)	Nutrient retention Sediment retention	Can reduce 20% more runoff than cropland	N/A
Agriculture	Crops	None	Level of risk dependent on land use practices: time-window for bare soil, amount of row cropping, field slope, organic matter content of soil, etc.	N/A
Developed	Residential Roadways Commercial	None	Above 10% impervious land cover degrade. A second threshold is likely reached at the 25 to 30% level.	**Poor: >1 impervio** **Fair: 10% area** **Good: <8 impervio**

Beneficiaries

Area	Beneficiary Group	Benefits	Notes
Hunting/Fishing Area	Hunters/Anglers	Food, Cultural Service	Any areas identified during consultati
Agricultural Area	Farmers	Food production, Livelihood	Agricultural areas, farms and croplan
Trails	Motorized and non-motorized recreation	Cultural services (recreation)	Motorized and non-motorized trail ne
Transportation	Public; business	Safety/security; livelihoods	Roads; rail

Buildings	Public; business	Safety/security; livelihoods	Buildings in study site
Wells	Public	Drinking water	Well database; estimate based on ho serviced area.

Appendix 8: Ecosystem Service Tool Database

Name	Type of Tool	GIS Required?	Scale	Free?	Training Required?	Necessary Experience	Availability	What does it do?
ARIES	Framework	No/Non	Watershed	Yes	Yes	Modelling background recommended	2018	Produces maps to exp demand, and delivery; supports validation may be necessary; supports fo
Co$ting Nature	Model	No/Non	Various	Yes	No	Minimal experience required, online training recommended	Available	Web based tool for ana ecosystem services, identifying the benefici assessing the impacts of human inter
NatureServe - Biodiversity Indicators	Other	No/Non	Basin	Yes	No	Interpretation of maps, limited experience necessary	Available	Visually presents vario biodiversity indicators basin level
InVEST	Model	Yes/Oui	Various	Yes	No	Modelling/GIS experience necessary	Available	Offers suite of modules spatially explore various ecosystem ser
iTree	Model	No/Non	Various	Yes	No	Some GIS experience necessary	Available	Assess the benefits of services provided by trees
LUCI *(Not released for general use)*	Framework	No/Non	Various	Yes	No	N/A	Unknown	Explores the capability to provide ecosystem ser
TESSA	Framework	No/Non	Site level	Yes	No	Varied, GIS/modelling may be required	Available	Compares alternative simplicity and stakeholder engag
WESP-AC	Other	No/Non	Site level	Yes	Yes	Some background in biology (particularly wetland plants) is beneficial, but not required	Available after training	Assess functions and b wetlands using office and in-field

SOLVES	Model	Yes/Oui	Various	Yes	No	Expertise in GIS/modelling	Available	Provides information o value of ecosystem services
NatureServe - Vista	Model	Yes/Oui	Various	Yes	No	Expertise in GIS/modelling	Available	Supports streamlined a different types of projects (e.g. conserva environmental assessments)
Global Forest Watch	Data	Yes	Various	Yes	No	Experience with GIS	Available	Spatial representation gain in different areas

Appendix 9: Planning Approaches to Reduce Inland Flood Risks

Local Government Best Management Practices to Enhance Natural Flood Risk Reduction and Other Ecosystem Services

Landscape Unit Link	Ecosystem Service Link	Type of Local Government Action	Description
All	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering; Erosion regulation; Recreation; Tourism	Comprehensive Planning (Planning)	Sets broad comprehensive goals for planning and can incorporate various aspects of flood risk reduction (e.g. goal o enhancing open space/park land in floodplains; Expresses a vision for the community and provides foundation for other planning practices.
All	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering.	Subdivision and site design standards; Clustering development (Planning)	Review site design standards can help ensure key natural are are protected that provide services to the community (e.g. ensuring subdivisions leave riparian areas for water quality, limiting lot development in hazard areas). Cluster subdivisions can also be used to cluster lots together to allow for more ope space within the broader subdivision
All	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering; Erosion regulation; Biodiversity;	Conservation Easements (Planning; Conservation)	Easement used to restrict development in an area, while still allowing the property owner to use, sell, and/or develop land in agreeable ways.
All	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering;	Parks and Open Space Plans (Planning)	Planning approach to identify, preserve, and monitor ope space/park space that can function to provide various ecosystem services

	Erosion regulation; Recreation; Tourism		
All	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering;	Conservation Zoning (Planning)	Zoning particular areas to discourage development (e.g. larger lots, use/density restrictions, larger setbacks). Ca be done in Canada as long as it does not limit public access (see link for more details)
All	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering; Erosion regulation; Recreation; Tourism	Conservation Fund (Monetary Approach)	Taxation system that reinvests community money into conservation projects.
All	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering;	Rainwater Management Plan (Planning)	Plan outlining process for how rainwater can be manage on-site to reduce runoff. Could be implemented for new developments, etc.
All	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering; Erosion regulation;	Security Deposits (Financial Disincentive)	Developer pays security deposit and if they negatively impact local ecosystem, that deposit is used to pay to reduce damages
All	Natural hazard mitigation; Water-flow regulation; Water purification/water	Regulatory Bylaws (Regulations)	Proactive and reactive approach to managing specific activities on development sites. (e.g. tree protection, watercourse, invasive species bylaws).

	filtering; Erosion regulation;		
All	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering; Erosion regulation;	Enforcement (Regulations)	Enforcement strategies can range from public education ticketing/fines to injunctions. Effective in stopping or requiring specific activities. For a full list of strategies vis the link provided.
Developed Streams/Rivers Wetlands Riparian Area	Natural hazard mitigation; recreation; Water-flow regulation; Air quality regulation; Water purification/water filtering; Erosion regulation	No Adverse Impact Zoning (Planning)	Regulation that new developments are not allowed to negative impact neighbouring developments (e.g. via stormwater runof water quality, etc.). Can be used at local or watershed scale.
Developed	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering; Erosion regulation	Bulk Regulations (Planning)	Minimum building setbacks, open space requirements, and flo area ratio requirements. Limits hard surfaces on an individual property basis. Bulk regulations are most effective when combined with a commitment from all stakeholders to limit variations in zoning/bylaws.
Developed	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering; Erosion regulation	Stormwater Credits (Asset Management, financial incentive program)	Credit program offered to homeowners who reduce stormwate runoff. Fee/credit system is based off of size of roof area in Mississauga, for example.
Developed Streams/Rivers Riparian Area	Natural hazard mitigation; Water-flow regulation; Water purification/water	Urban Green Infrastructure (Asset Management)	Development of green roofs, naturalizing parking lots, etc.

	filtering;		
Developed Streams/ River	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering; Erosion regulation;	Property Buyouts	Local governments purchase vulnerable properties in order to restrict future development, can be done after major event or voluntarily. Consultation is a critical part of this process to ens buy-in.
Developed Streams/Rive rs	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering; Erosion regulation;	Flood Resilient Culverts (Engineering design, public works)	Assessing and repairing culverts following a regular schedule and implementing best practices to ensure effective operation
Developed Forest Wetland Grassland	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering; Erosion regulation	Density Bonusing (Planning)	Allow for greater density of development on a site if it preserv open space in adjacent areas. To be most effective, the area protected should be designated under a conservation easeme by the developer.
Developed Streams/ Rivers Riparian Area	Natural hazard mitigation; Water-flow regulation; Erosion regulation	Post-Disaster Building Moratorium (Planning)	Restricting development in areas post-disaster. Typically, this based off of disaster thresholds but can be unpopular. Over th short term, this strategy can help to identify where building ba can be permitted.
All	Natural hazard mitigation; Water-flow regulation; Water	Critical Infrastructure Protection Plan (Planning)	Developing a strategy to review any critical infrastructure in th community and how it may be affected by flooding events (an other hazards). This is an important exercise as it can also he identify what natural assets are important to preserve in order protect the critical infrastructure

	purification/water filtering; Erosion regulation		
All	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering; Erosion regulation; Recreation; Tourism	Amenity Bonusing (Planning)	Agreement between local government and developer. T developer received approval for higher density development, if they provide an amenity for public acces (e.g. parkland). This can serve to protect ecosystem services, but can be controversial (see examples attach
Forest Riparian Area Streams/ Rivers Forests Wetlands Grassland	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering; Erosion regulation; Recreation; Tourism	Open Space/Land Acquisition (Conservation)	Municipality purchases land or has land donated which is left open space, with little maintenance. Dual benefit of providing ecosystem services and reducing risk as there is no develope land there
Riparian Streams/ Rivers Wetlands	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering; Erosion regulation;	Floodplain Mapping (Planning)	Ensuring floodplain mapping includes the entire floodway and natural features that can reduce flood peaks to capture the complete system in order to restrict development in these are
Riparian Area Streams/ Rivers	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering; Erosion regulation;	Setback or Horizontal Levees (Engineering)	Earthen embankments set-back from the river areas, allows fo natural flow that slows down water before impacting the levee itself and reducing its damage

Riparian Area Streams/ Rivers	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering; Erosion regulation; Recreation; Habitat for Species; Biodiversity	Daylighting Stream/Rivers (Conservation)	Removing obstructions from stream/rivers help to open the system to better manage water flows, also serves to provide additional ecological benefits
Riparian Area	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering; Biodiversity; Habitat	Riparian Tax Exemptions (Financial incentive)	Conservation easement/covenant that provides tax exemption to private landowner who agrees to maintain/restore natural riparian zone on their property
Streams/ Rivers Riparian Area Grassland	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering; Erosion regulation; Recreation; Tourism	Waterfront Parks (Conservation)	Purchase/reclaim land along watercourse and develop park fo recreation, etc. that is expected to flood during major events
Streams/ Rivers Riparian Area	Natural hazard mitigation	Flood Zone Permitting (Planning)	Restricting development in mapped floodplains and/or requirin applications to develop in floodplain
Streams/ Rivers Developed Riparian Area Forests	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering;	Runoff Control Requirements (Planning)	Requirements for certain proportion of impervious area t reduce runoff off of property. Particularly useful in the context of climate change and flooding.
Wetlands	Natural hazard	Naturalized	Natural or naturalized wetland complex with native vegetation

Riparian Area	mitigation; Water-flow regulation; Water purification/water filtering; Erosion regulation; Recreation; Tourism	Stormwater Ponds (Engineering design)	that acts as a detention area for flood water. Also provides recreation, water quality, and property value enhancements. Rainwater design control measure
Wetlands Riparian Area Streams/ Rivers	Natural hazard mitigation; Water-flow regulation; Water purification/water filtering; Erosion regulation; Recreation; Tourism	Environmental Development Permit Areas (Planning)	Designated area on specific properties that requires specific considerations (e.g. buffers, restoration, construction restrictions). These considerations must be determined pre-construction. Areas are determined in Community Plan (e.g. all wetlands). Challenging due to time and compliance issues, as well as enforcement challenges.

Additional Reading

[1] Colorado "Planning for Hazards": <https://www.planningforhazards.com/flood>
[2] Deborah Curran, Economic Benefits of Natural Green Space Protection (2001) <http://www.smartgrowth.bc.ca/Portals/0/Downloads/Economic%20Benefits%20of%20Natural%20Green%20Space%20Protection.pdf>
[3] Naturally Resilient Solutions <http://nrcsolutions.org/>
[4] Green Bylaws Toolkit http://www.greenbylaws.ca/documents/GreenBylawsToolkit_2016.pdf
[5] No Adverse Impact Planning How-to Guide. (2014). Retrieved from, http://www.floods.org/ace-images/PlanningFinal6_16_16.pdf

Appendix 10: Example BMP Implementation Plan

Date: **February 2018**
Site Name: **001**

List of Threatened Landscape Units (results from Step 2). Select all priority landscapes (X)

- Forest ( )
- **Wetland** **(x)**
- **Riparian Area** **(x)**

- Streams/Rivers ( )
- Grassland/Agriculture ( )
- Barrens (Nova Scotia) ( )
- Other ( )

What three best management practices presented in Step 3: Action are most feasible to implement in your area?

1. **Naturalized Stormwater Ponds**
2.
3.

Record any information how these BMPs could be adjusted to meet your needs your local context? Include information on what process is required to implement the BMP, relevant timelines, and how it will help the threatened landscape unit.

1. **BMP: Naturalized Stormwater Pond**

Partners/Regional Expertise (please consult MNIC for contacts):

- **Ducks Unlimited Canada**
- **City of Moncton**

Process:

- **Contact organizations with experience developing Naturalized Ponds**
- **Assess priority sites and secure funding**
- **Begin construction**
- **Monitor pond performance over time**

Timeline:

- **Year 1: Get educated; assess priority sites; apply for funding**
- **Year 2: Begin construction**
- **Year 3: Monitor changes**

Gaps/Concerns

- **Lack of knowledge; funding**

How will it help?

- **Help to filter water, and provide other ecosystem services while also reducing risk of flooding that may have been increased by recent developments/activities upstream**

2. BMP:
Partners/Regional Expertise (please consult MNIC for contacts):
Process:
Timeline:
How will it help?:

3. BMP:
Partners/Regional Expertise (please consult MNIC for contacts):
Process:
Timeline:
How will it help?:

Land-use Planning: Maritime Context

Land-use planning is implemented differently among the three provinces, but has the overall goal of organizing and regulating land use in an efficient and mutually beneficial way.

In New Brunswick, land-use planning primarily falls under the responsibility of the Regional Service Commissions who provide planning services to local incorporated and unincorporated areas in their district. In Southeast New Brunswick, the Southeast Regional Service Commission is responsible for supporting and developing municipal/rural plans, development, etc. (excluding City of Moncton, Riverview, and Dieppe). The Southeast Regional Service Commission has prepared a useful document for planners in the region summarizing how ecosystem services related to inland flood risk reduction can be integrated into the planning process. The report can be found on the MNIC website here: www.planwithnature.ca

In Nova Scotia, land use planning is responsibility of municipalities who are tasked in drafting both a Municipal Planning Strategy as well as Landuse Planning Bylaws to develop and enforce a planned vision. Nova Scotia also has Provincial Statements of Interest which present a vision for protecting the province's land and water resources moving forward.

In Prince Edward Island, municipalities have taken on the responsibility of regulating land use within their boundaries to make their own land use planning decisions. The Provincial Planning Division of the Department of Communities, Land and Environment makes land use planning decisions for the land area that lies outside the boundaries of the municipalities. All land use planning decisions are appealable, as per the Planning Act, and appeals are directed to the Island Regulatory and Appeals Commission. Environmental protection exists through the Environmental Protection Act which includes Watercourse and Wetland Protection Regulations, which require permits for any activities that occur in proximity to such areas. These permits are issued entirely by the Province. All municipalities are required to develop land-use planning strategies by December 2022.

List of Maritime Natural Infrastructure Collaborative Partners

Coordinator
Nature NB

Members
Dalhousie University School of Planning
Island Nature Trust
Canadian Parks & Wilderness Society – NB Chapter
Aster Group
Nature Conservancy of Canada
Southeast Regional Service Commission
Université de Moncton
Parks Canada
Shediac Bay Watershed Association
Vision H2O
EOS Eco-Energy, Inc.
Petitcodiac Watershed Alliance
Ducks Unlimited Canada
Bluenose Coastal Action Foundation
Clean Annapolis River Project
Sackville Rivers Association
Atlantic Canada Conservation Data Centre
Central Queens Wildlife Federation
Trout Unlimited Canada – Prince County Chapter
Fundy Biosphere Reserve
Atlantic Canada Organic Regional Network
Nashwaak Watershed Association

Funders
We would like to recognize the contribution of the following funders to our initiative

Environment and Climate Change Canada
New Brunswick Environmental Trust Fund