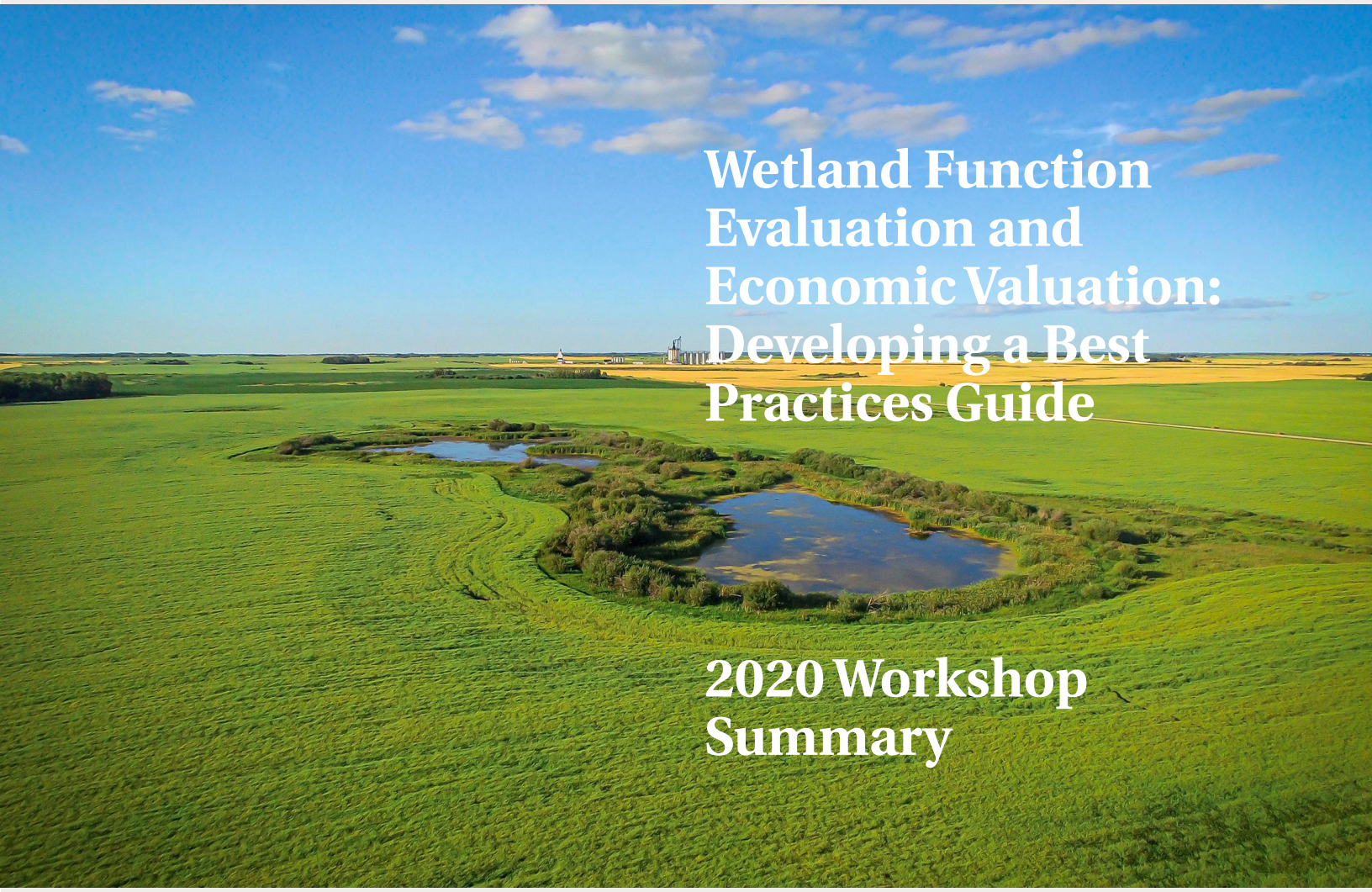
CANADIAN WETLANDS ROUNDTABLE



Wetland Function Evaluation and Economic Valuation: Developing a Best Practices Guide

2020 Workshop Summary

Sponsored by the Canadian Federation of Agriculture and Ducks Unlimited Canada

About the Canadian Wetlands Roundtable

The Canadian Wetlands Roundtable (Roundtable) is a multi-stakeholder partnership of Industry, conservation organizations and Environment and Climate Change Canada. The Roundtable was formed to conserve and improve the management of Canada's wetlands for the health, safety and well-being of people and the thousands of species that depend on these habitats for survival.

Since 2015, the Roundtable has been dedicated to putting wetlands on Canada's national agenda in a way that fosters sustainable land and resource use, while drawing attention to the unique role that these "super ecosystems" play in mitigating climate change and halting and reversing biodiversity loss. Co-chaired by Ducks Unlimited Canada and the Canadian Sphagnum Peat Moss Association, the goal of the Roundtable is to advance wetland conservation in partnership with other sectors.

The following workshop summary on Wetland Function Evaluation and Economic Valuation: Developing a Best Practices Guide is a product of the Roundtable's efforts.

For information about the Canadian Wetlands Roundtable, please visit canadianwetlandsroundtable.ca/.

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Acknowledgements

The Canadian Wetlands Roundtable is grateful to all those individuals who contributed their time and expertise at the January 21-22, 2020 Wetland Function Evaluation and Economic Valuation workshop held in Ottawa, Ontario. The workshop was made possible through a grant from Wildlife Habitat Canada to the Canadian Federation of Agriculture (CFA). In collaboration with the CFA, Ducks Unlimited Canada (DUC) organized and hosted the workshop at their offices.

The Roundtable is grateful for the support and guidance from our dedicated team of experts (the Project Team) in the planning and follow-up of the 2020 workshop. A thank you also to Dr. Paul Adamus who kindly provided additional considerations for guiding future work.

Project Team

Dr. Paul Adamus, Adamus Resource Assessment, Inc.
Dr. Pascal Badiou, Ducks Unlimited Canada
Dr. Kenneth Belcher, University of Saskatchewan
Dr. Peter Boxall, University of Alberta
Alan Hanson, Canadian Wildlife Service-Environment and Climate Change Canada
Patrick Lloyd-Smith, University of Saskatchewan

For a list of the Project Team and workshop participants, see Appendix 1.

Special thanks to Gregory Thompson, (2020-21 Roundtable Coordinator) for assisting with workshop funding and preparations, facilitation of the two-day workshop and compilation of this report.

2023 Update: *While the global pandemic delayed the completion of this report, more recently DUC secured funding for the continued development of much needed methodologies supporting wetland inventory/evaluation and economic valuation. The 2020 workshop findings, along with work completed in the months following, represent a significant contribution to this continuing and critical effort to establish the true biological, cultural, social, economic and public health and safety value of Canada's wetlands for government decision makers, resource sectors and all Canadians.*

Acronyms and Abbreviations

CFA	Canadian Federation of Agriculture
CICES	Common International Classification of Ecosystem Services
CWR	Canadian Wetlands Roundtable
CWS	Canadian Wildlife Service
DUC	Ducks Unlimited Canada
ECCC	Environment and Climate Change Canada
EGS	Ecological Goods and Services
EU	European Union
GIS	Geographic Information System
LiDAR	Light Detection and Ranging
MAES	Mapping and Assessment of Ecosystems and their Services
WESP	Wetland Ecosystem Services Protocol

Terms and Definitions

- **Inputs** include physical, chemical and biological items and processes that support wetlands and their functions
- **Functions** are what some wetlands do naturally without human intervention (e.g., store water)
- **Ecosystem Services** are derived from ecosystem functions and are the benefits humans receive from nature (e.g., flood control); can be measured using monetary or non-monetary calculations
- **Wetland Biological Evaluation** refers to the biological assessment of the ecological services that wetlands provide including carbon sequestration, water quality improvements and flood control along with wildlife values such as species at risk habitat
- **Wetland Economic Valuation** refers to assessment of the direct and indirect economic value of wetland goods and services to Canadians, such as soil retention and flood control, as well as recreational activities like birding, hiking, hunting, fishing and trapping

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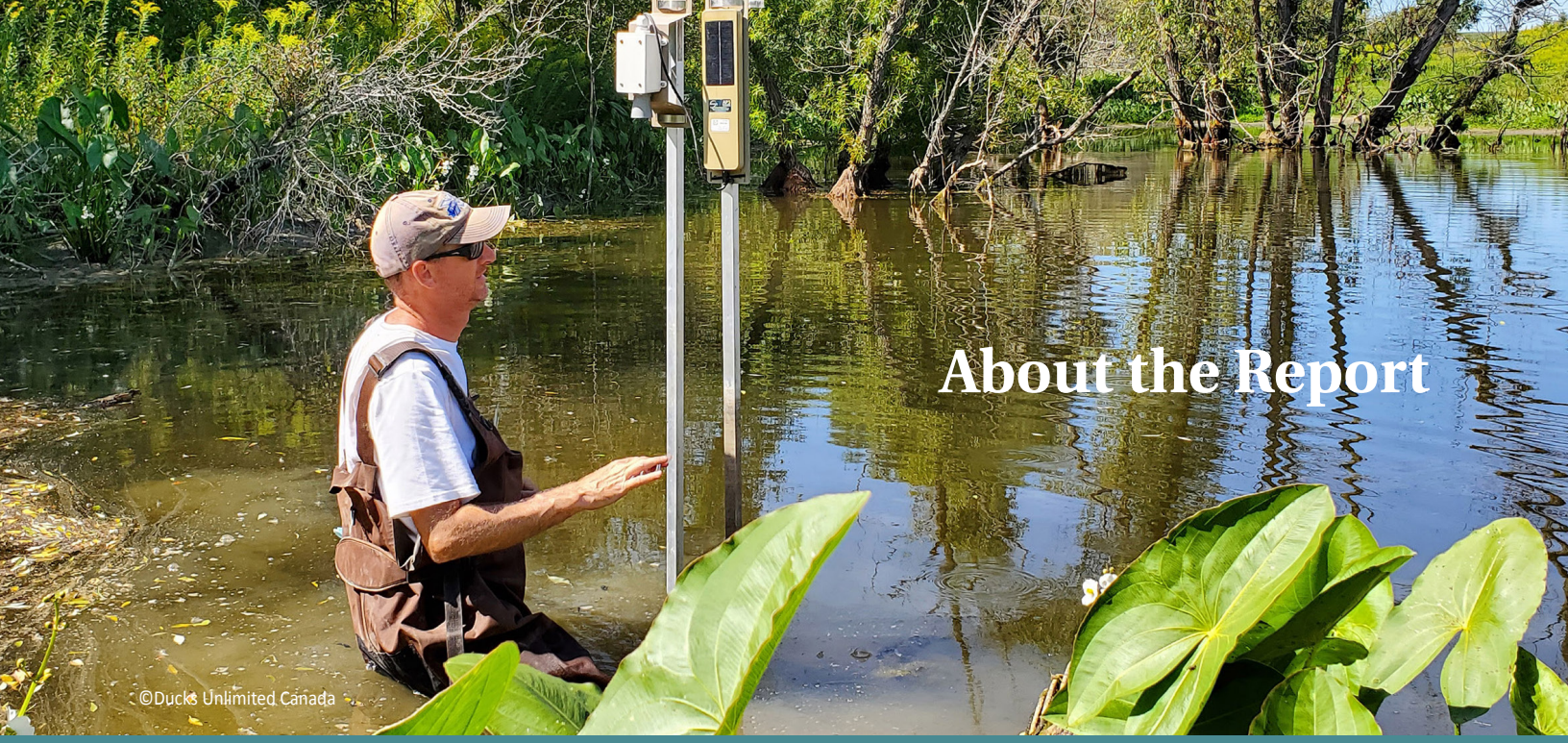


About the Report

The Canadian Federation of Agriculture (CFA), with the support and assistance of Ducks Unlimited Canada (DUC), secured a grant from Wildlife Habitat Canada in 2018. The purpose of the grant was to enable the Canadian Wetlands Roundtable (CWR) to review and update Canada's *1992 Wetland Evaluation Guide* (Bond et al 1992) based on current science, evolving practices and new methodologies.

The process involved multiple phases and outputs, supported by a highly qualified team of CWR-recommended practitioners (the Project Team). The Project Team catalyzed the development of a set of best practices for the evaluation of ecological functions and economic valuation of wetland benefits. A key part of their work plan called for the hosting of an experts' workshop in January 2020. The purpose of the workshop was to explore the state of knowledge on wetland function evaluation and economic valuation in Canada, and to recommend a framework and next steps for the development of an up-to-date best practices guide.

The following report, delayed due to the impact of the global pandemic, summarizes that workshop which was held January 21-22, 2020 in Ottawa, Ontario.

This report summarizes the background and key findings of the workshop, while the principal workshop accomplishment, a Best Practices Guide: *An Annotated Outline and Technical Road Map*, may be found in Appendix 3.

It will guide CWR's work on wetland valuation and evaluation which is currently funded by Environment and Climate Change Canada's (ECCC) Nature-Smart Climate Solutions Fund.

Background – 2017 Ecological Goods and Services Workshop

The ability to evaluate wetland functions and to place an economic value on their ecological goods and services (EGS), and the best practices needed to do so, are critical to wetland conservation and management. In Canada, this is an area in need of development and should include a comprehensive approach with directed studies.

CWR has long recognized this need and convened a wetland EGS workshop February 9-10, 2017, in Ottawa, aimed at establishing a better understanding of the importance of, and science behind, the EGS that wetlands provide. Approximately 50 wetland specialists from various interests and disciplines from Canada and the United States participated.

The 2017 workshop identified wetland EGS information gaps. It highlighted the fact that EGS are given consideration in various wetland policies across Canada, particularly those policies that call for “no net loss of function” and “no net loss of benefits.”

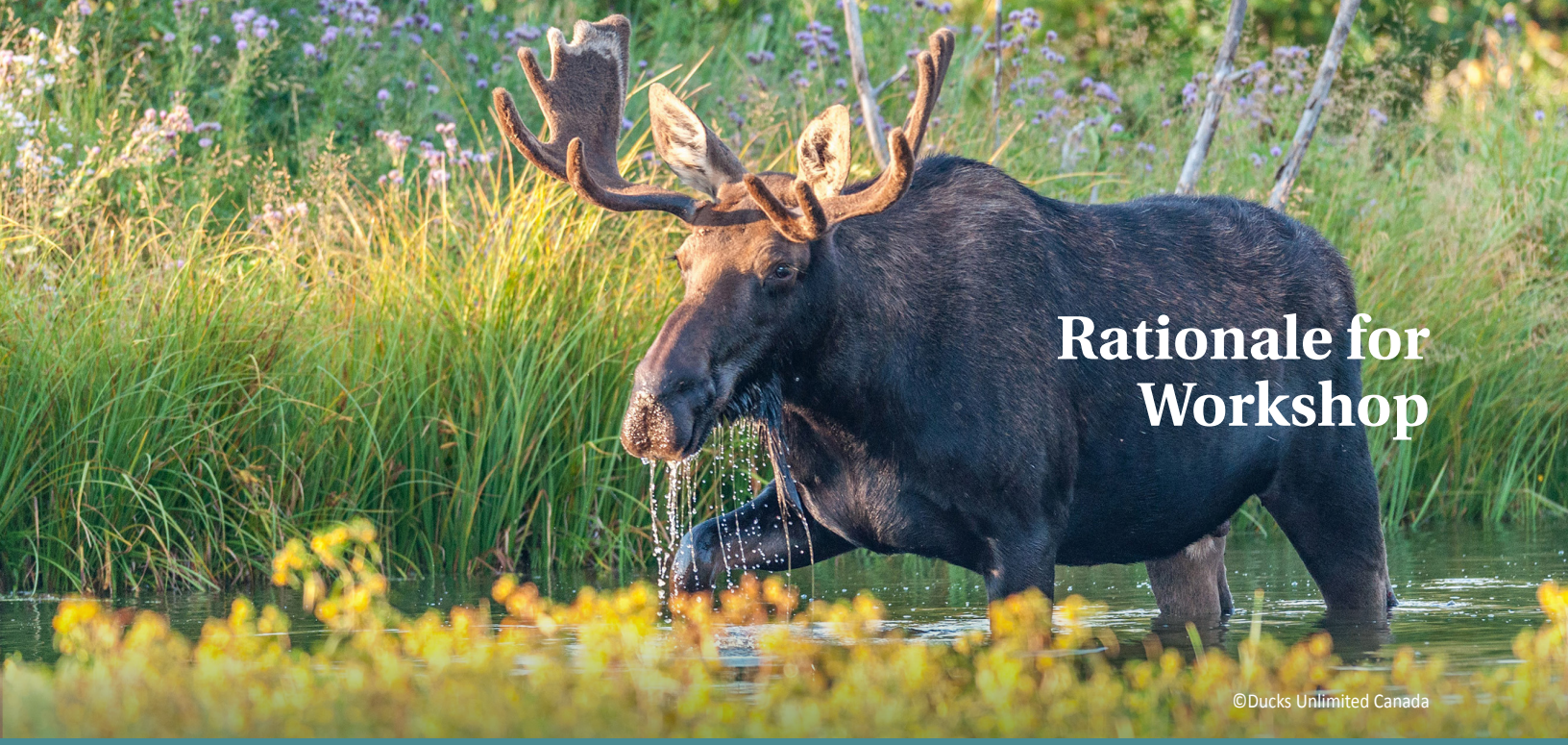
It was specifically noted that wetland valuation is particularly needed where unavoidable wetland loss or alteration requires compensation, either through fines or habitat restoration. Yet in each of these policy and compensation scenarios, it was clear to workshop participants that the solutions being implemented do not always achieve the intent of the policy.

The 2017 workshop participants also agreed that the absence of a clear and consistent EGS evaluation framework hinders the effective and efficient quantification of wetland function and EGS value in Canada. Proper valuation will, the participants noted, lead to information-based decision making in the design of policies and programs to support conservation outcomes for Canada’s wetlands.

These changes would improve wetland conservation, protection and management decisions at a landscape and watershed planning scale. Participants concluded that the quantification of wetland EGS will remain *ad hoc* in Canada unless steps are taken by all jurisdictions to establish a clear and consistent framework.

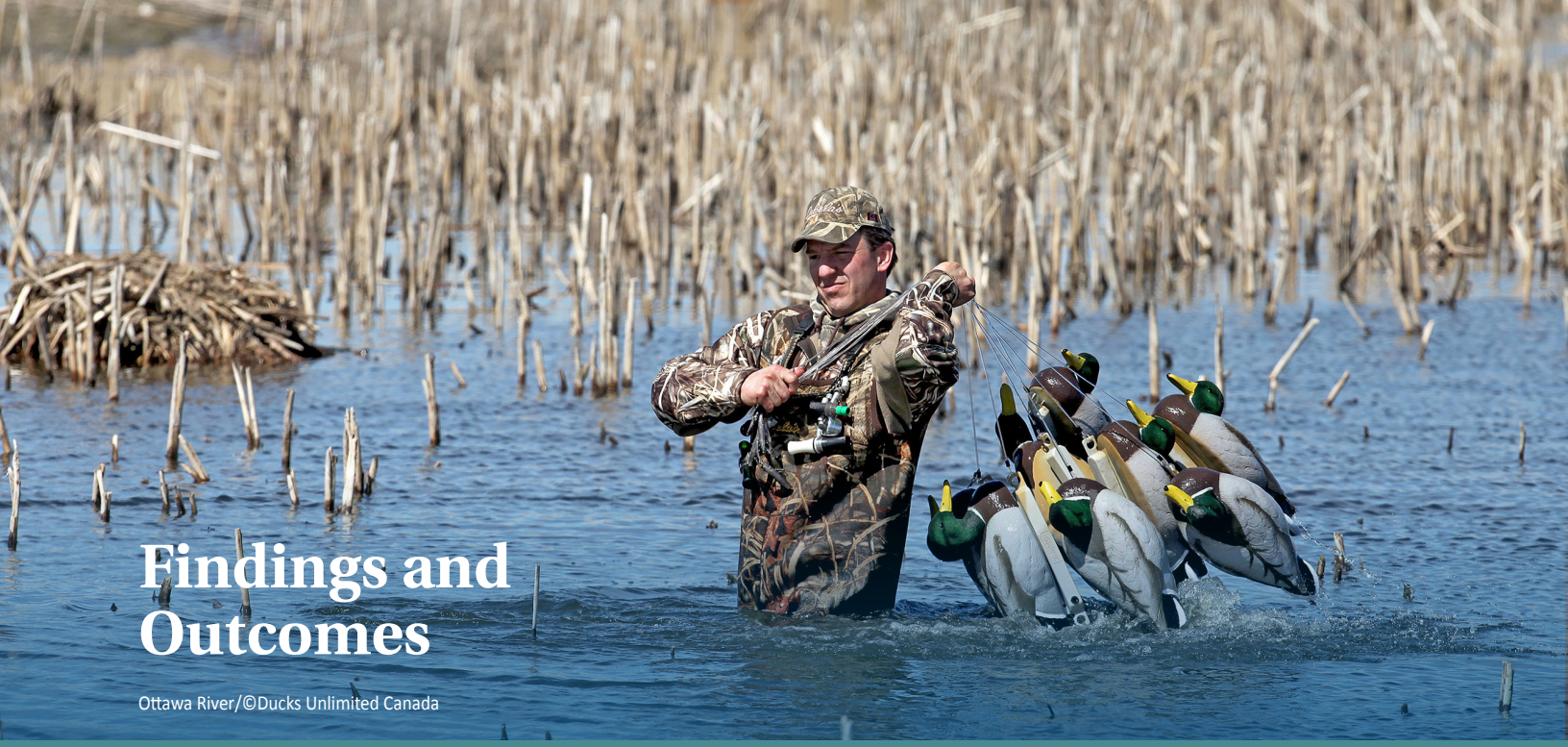
A key recommendation from the 2017 workshop called for the priority development of a best practices guide that incorporates both the inventory/evaluation of wetland function and the economic valuation of wetland benefits.

The 2017 EGS workshop report may be found on the CWR website canadianwetlandsroundtable.ca.



Rationale for Workshop

In the face of growing competition between wetlands and alternate land uses, CWR members agreed that the business case for wetland conservation—supported with substantive data on the value and benefits of the EGS that wetlands provide—would greatly assist wetland conservation and protection efforts. Development of best practices for wetlands evaluation/valuation were also considered a high priority in order to support the successful implementation of a growing suite of both federal and provincial wetland loss and impact mitigation policies. While these government policies variously call for the "no net loss" of wetland function and benefits and require the offset of wetland losses where mitigation of impacts is not feasible, as subsequent CWR investigations have revealed, the full implementation of these wetland policies continues to be described as deficient.



Findings and Outcomes

Ottawa River/©Ducks Unlimited Canada

Taking up the findings and recommendations of the 2017 EGS workshop, CWR revisited Canada's *1992 Wetland Evaluation Guide*. It was generally understood that this 30-year-old document was in need of updating with current science, practices and methodologies. In the course of planning the update, CWR also proposed three criteria for the development of an up-to-date best practices guide for both wetland evaluation and economic valuation. To be most effective, the revised guide would need to be practical, adaptable to multiple needs and circumstances and readily applicable.

With these goals in mind, CWR secured project funding and assembled the Project Team (Appendix 1) to provide guidance. The Project Team recommended the hosting of an experts' workshop in 2020 to explore the state of knowledge on wetland function, evaluation and economic valuation in Canada, and recommend a framework and next steps for the development of a best practices guide.

The workshop was held January 21-22, 2020 in Ottawa, Ontario and was attended by 14 experts (Appendix 1) drawn from government and non-governmental organizations and Industry representatives from Canada and the United States. The workshop agenda may be found in Appendix 2.

Key Findings

Preparatory work led by CWR in the summer and fall of 2019, the January 2020 workshop results and subsequent meetings with the Project Team, led to agreement on a three-point action plan:

(i) Acknowledge & Address Existing Shortcomings

A review of the current wetland policy and program landscape revealed that Canada's capacity to evaluate ecosystem function and place a value on wetland benefits suffers from many shortcomings. These include:

- A persistent failure to recognize that wetland inventories and the economic valuation of wetlands are intimately linked
- The quality of economic valuations of wetlands is only as good as the quality of the biological, social and cultural data produced by wetland inventories
- A lack of common language, particularly across the biological and economic disciplines
- Absence of a straightforward framework to guide both wetland biological evaluation and economic valuation
- A lack of Canadian economic, biological and social science data/case studies to support and refine evaluation/valuation efforts
- Absence of proven Canadian evaluation/valuation methodologies

(ii) Adopt a Common Approach to Best Practices

Additionally, and in response to these shortcomings, workshop participants concluded that the key obstacles to effective and practical wetland function evaluation and economic valuation can be best overcome by implementing the following:

- Establish common wetland terminology and definitions
- Establish value for both wetland function and services
- Leverage both domestic and international practices
- Provide practical guidance
- Acknowledge the methodological and operating limitations

(iii) Develop a Best Practices Guide for Evaluation and Economic Valuation

Workshop participants agreed that a Canadian Best Practices Guide for Wetland Function Evaluation and Economic Valuation needed to:

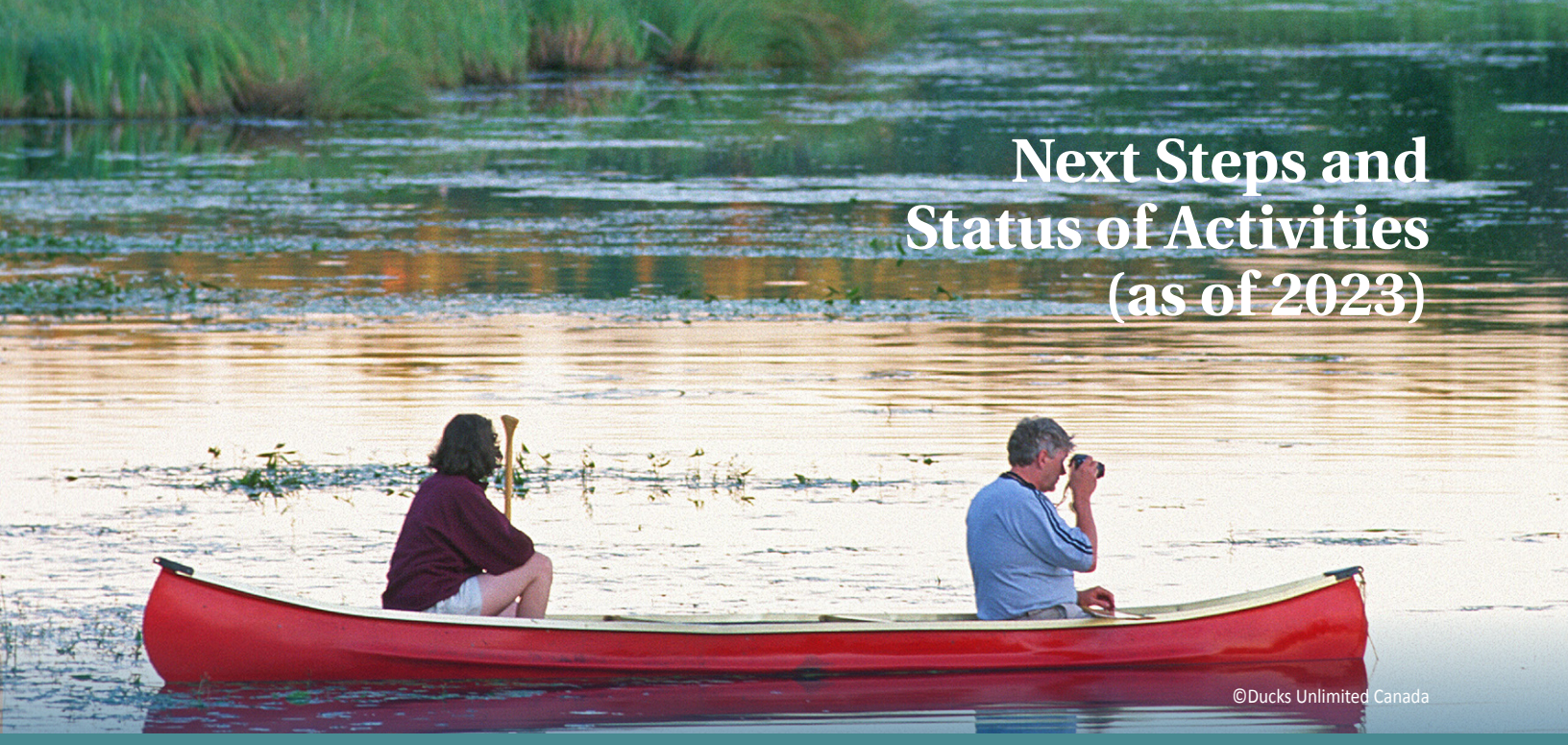
- Provide practical "how-to" guidance for practitioners in the field
- Be comprehensive across projects, impacts, needs and scale
- Illustrate best practices using successful examples
- Identify future research and methodology development requirements

Outcomes and Post-Workshop Follow-up

Direction from the workshop participants and subsequently from the Project Team led to the preparation of an annotated draft outline of a *Best Practices Guide: An Annotated Outline and Technical Road Map* (Appendix 3). The draft annotated outline identifies the recommended elements of a comprehensive Best Practices Guide to wetland function evaluation and wetland services valuation. Practices that must be responsive to on-the-ground implementation complexities include:

- multiple sources of impacts on wetlands
- varying evaluation/valuation purposes
- data deficiencies
- differences of scale and scope
- resource, expertise and time constraints
- jurisdictional differences in wetland avoidance

Included in this draft Best Practices Guide is a technical road map for the further development of best practices methodologies. The road map identifies the key biological evaluation and economic valuation functions and decision points for which best practices are either recommended or will be required. Once completed, the Best Practices Guide will provide practitioners with the evaluation and valuation methodologies that best fit their particular field circumstances and study needs. References and information sources may be found in Appendix 4.



Next Steps and Status of Activities (as of 2023)

The 2020 workshop report and proposed framework are intended to serve as the basis for further work by the CWR Project Team, resources permitting. The next steps to develop an up-to-date Canadian Wetlands Evaluation and Valuation Best Practices Guide for use by Canadian jurisdictions, the public and private sectors (updated as of 2023) are as follows:

- Finalize workshop report with input from Project Team and workshop participants and post on the CWR website (summer 2023)
- Document government wetland evaluation and valuation policies, requirements and programs at the federal, provincial and territorial levels (currently underway with the support of DUC)
- Incorporate the 2020 Workshop findings into CWR's ongoing work on wetland valuation and evaluation currently funded under separate projects through ECCC's Nature-Smart Climate Solutions Fund (currently underway)

Appendix 1: Project Team and Workshop Participants

Participants	Affiliation
Dr. Paul Adamus (Project Team)	Wetland Consultant Adamus Resource Assessment, Inc. Corvallis, Oregon
Frank Annau (CWR Co-chair)	Director of Environment and Science Policy Canadian Federation of Agriculture Ottawa, Ontario
Dr. Pascal Badiou (Project Team)	Research Scientist Institute for Wetland and Waterfowl Research Ducks Unlimited Canada Stonewall, Manitoba
Dr. Peter Boxall (Project Team)	Professor Department of Resource Economics and Environmental Sociology University of Alberta Edmonton, Alberta
Jim Brennan (CWR Steering Committee)	National Director, Industry & Government Relations Ducks Unlimited Canada Ottawa, Ontario
Dr. Ken Belcher (Project Team)	Professor Department Head Agricultural and Resource Economics University of Saskatchewan Saskatoon, Saskatchewan
Dr. Shari Clare	Director Senior Biologist Fiera Biological Consulting Edmonton Alberta
Alan Hanson (Project Team)	Head Aquatic Assessment Canadian Wildlife Service-Environment and Climate Change Canada Atlantic Region
Pat Kehoe (CWR Co-chair)	Chief Conservation Officer Ducks Unlimited Canada Stonewall, Manitoba

Patrick Lloyd-Smith (Project Team)	Assistant Professor Department of Agriculture and Resource Economics Global Institute for Water Security University of Saskatchewan Saskatoon, Saskatchewan
Dr. Miriam Matejova	Economic Advisor Regulatory Analysis and Valuation Strategic Policy Branch Environment and Climate Change Canada Ottawa, Ontario
Andrew Robinson	Senior Environmental Assessment Officer Canadian Wildlife Service- Environment and Climate Change Canada Vancouver, British Columbia
Sarah Todgham (CWR Steering Committee)	Manager Sustainability and Environmental Regulations Forest Products Association of Canada Ottawa, Ontario
Mark Walker (CWR Steering Committee)	Manager Policy Development Canadian Canola Growers Association Winnipeg, Manitoba
Christie Ward	Director Source and Surface Water Management New Brunswick Department of Environment and Local Government Fredericton, New Brunswick
Gregory Thompson (CWR Coordinator)	Coordinator (2018-2020) Canadian Wetlands Roundtable and Principal, T&M Consulting Inc. Ottawa, Ontario

Appendix 2: Workshop Agenda

Day One: Tuesday January 21, 2020 (9:00 am-4:30 pm)

Welcome / Introductions: Pat Kehoe and Frank Annau (CWR Co-chairs)

- Purpose, Agenda and Outcomes: Gregory Thompson (CWR Coordinator)
- Day One Tasks: Introduction
  - Task 1: *Test and Confirm Framework Feasibility*
    - Review/refine the Road Map headings and intended content
  - Task 2: *Refine Functions Evaluation Section and Populate*
    - Road Map Section 1: Wetlands Ecological Functions Evaluation
  - Task 3: *Refine Goods/Services Valuation Section and Populate*
    - Road Map Section 2: Wetland Ecosystem Good and Services Valuation
- Wrap up and Accomplishments: Pat Kehoe and Frank Annau

Day Two: Wednesday January 22, 2020 (9:00 am-3:00 pm)

Review of Agenda: Pat Kehoe and Frank Annau

- Day Two Tasks / Introduction: Gregory Thompson
  - Task 4: *Project Governance and Work Plan*
    - Confirm team role, membership
    - Identify key tasks and timelines
  - Task 5: *Preparation of Draft Best Practices Guide*
    - Confirm general content
    - Identify key information sources
    - Drafting responsibilities
    - Timelines
  - Task 6: *Steps to Finalize the Best Practices Guide*
    - Outreach and engagement (public/private/non-profit/academia)
    - Budget needs and sources
    - Timelines
- Workshop Wrap-up: Pat Kehoe and Frank Annau
  - Accomplishments and acknowledgements
  - Workshop report preparation
  - Next Steps and responsibilities

Appendix 3: Best Practices Guide: Annotated Outline and Road Map

Notes to readers: *This draft annotated outline, along with the associated technical road map, provides a framework for the development of a guide to best practices for the biological evaluation and economic valuation of wetlands in Canada. This draft outline is based on the findings of the 2020 workshop and benefits from subsequent advice and input from members of the Project Team particularly Dr Ken Belcher, Patrick Lloyd-Smith and Dr. Paul Adamus. Gaps in the text remain as placeholders for further work.*

Annotated Outline

1. **Introduction**
   - Canadian Wetlands Roundtable
   - About the Project and Team
   - Purpose of the Guide – rationale, scope, goal

2. **Terms and Definitions**

   To support communications and common understanding in the development of this framework, and the subsequent preparation of a Best Practices Guide, standardized terminology of function, services and benefits are needed:
   - **Inputs** include physical, chemical and biological items and processes that support wetlands and their functions
   - **Functions** are what some wetlands do naturally without human intervention (e.g., store water)
   - **Ecosystem Services** are derived from ecosystem functions and are the benefits humans receive from nature (e.g., flood control); can be measured using monetary or non-monetary calculations
   - **Wetland Biological Evaluation** refers to the biological assessment of the ecological services that wetlands provide including carbon sequestration, water quality improvements and flood control along with wildlife values such as species at risk habitat
   - **Wetland Economic Valuation** refers to assessment of the direct and indirect economic value of wetland goods and services to Canadians, such as soil retention and flood control, as well as recreational activities like birding, hiking, hunting, fishing and trapping

3. Rationale – Wetland Evaluation and Economic Valuation Best Practices

Effective wetland evaluation and valuation methodologies and processes can play a significant role throughout the entire cycle of the wetland avoidance, impact mitigation, compensation and protection scenario typically managed by jurisdictions across Canada. Several jurisdictions in Canada have in fact adopted wetland conservation policies that support "no net loss" of wetlands, and in some instances their functions and benefits. But regardless of the management regime that is in place, effective and efficient valuation of wetland functions, and estimates of the economic value of the EGS these functions provide, is essential to support sustainable wetland loss offsetting programs that help compensate for wetland loss in the face of competing land use. Improved understanding of the economic value of wetland EGS can better establish their ecological, social and economic worth, inform markets and incentive programs and ensure that wetlands remain a component of healthy and sustainable landscapes well into the future.

Resolving competing values about the relative importance of Canada's natural resources and their conservation, including wetlands, will remain a challenge in achieving sustainable landscape management. Biological, ecological, economic and social research is critically important if Canada is to strengthen ecological evaluation and economic valuation and other wetland conservation practices.

4. The role of evaluation and valuation in the assessment, management and protection of Canada's wetlands

Wetland evaluation and economic valuation plays an important role throughout the entire suite of wetland use and conservation/protection scenarios typically managed by public institutions within the context of larger land/water management regimes. Once complete, Table 1 will depict the key roles that evaluation and valuation play in the ongoing conservation and management of wetlands, as well as suggest key performance criteria supporting their continual improvement.

Table 1: Wetland Management in Canada – The Role of Biological Evaluation and Economic Valuation

Part 1. WETLAND MANAGEMENT REGIME ELEMENTS					
POLICY	LEGISLATION	REGULATIONS	PROGRAMS	AUDIT & EVALUATION	NATTIONAL & INTERNATIONAL PARTNERSHIPS/COMMITMENTS
			SCIENCE		
			PLANNING		
			EIA		
			STEWARDSHIP		
			ENGAGEMENT		

Part 2. WETLAND AVOIDANCE, MITIGATION, COMPEMNSATION & PROTECTION FUNCTIONS							
WETLAND USE AND DEVELOPMENT SCENARIOS	INFORM & ENGAGE	EVALUATE FUNCTION & ASSESS VALUE	AVOID & PLAN	MINIMIZE ON-SITE IMPACTS	MITIGATE ON-SITE IMPACTS	COMPENSATE/ OFFSET: FEES & BANKING	MONITOR, REPORT & EVALUATE
LOST							
HIGHLY ALTERED							
MODEST ALTERATOINS							
UNALTERED							
PROTECTED							

Part 3. WETLAND MANAGEMENT - EVALUATION & PERFORMANCE CRITERIA	
INFORMED	Best available information: physical and social science, economics, etc.
ENGAGEMENT	Landowners, resource sectors, Indigenous & other communities
ADHERENCE	Mitigation sequence & enforcement of rules
EFFECTIVE	Wetland status & trends
EFFICIENT	Decision-making & transactional costs to proponents
FLEXIBILITY	Introduction of market-based instruments
METHOLOGY	Best practices & methodology (evaluation/valuation, etc.)
AUDIT/REPORT	Accountability, transparency & reporting

Source: G. Thompson, 2023

5. Canadian Wetland Policy: An Overview

- Overview of wetland policies in Canada (and by jurisdiction) especially with regard to how function, benefits and EGS are considered in jurisdictional policy statements, legislation, regulations and programs.
- Policy and regulatory relevance of wetland function evaluation and economic valuation: project-specific assessment, conservation investments, area-based planning and regulatory decision assessment.

As the CWR 2017 workshop highlighted, wetland EGS are given consideration in various wetland policies across Canada, including those that call for "no net loss of function," and particularly in instances where compensation for wetland development or alteration is required. Observers have noted that where compensation for loss is required, the loss of ecological functions are sometimes thought to be addressed by simple replacement ratios, such as impacted surface area. Without proper evaluation, this assumption can often be erroneous. Further, in some cases, consideration of ecological services requires the addition of economic analysis, for example, in any policy calling for "no net loss of benefits". Here the policy goal is clearly not supported with tested methodologies, a circumstance that invites regulatory failure, in addition to the challenges faced by land-use operators.

Aside from terminology and definitional problems inherent in this mix of policy statements and mitigation and compensation scenarios, practitioners noted that the compensation being implemented, such as the application of one compensation measure for the loss of all functions, often does not achieve the intent of the policy. Clarity on the meaning of, and methodologies for, ecological function evaluation and the economic valuation of wetlands, will contribute significantly to informing and guiding the implementation of successful wetland loss mitigation and compensation policies.

Recently, the efficacy of 'no net loss' has come under question in several reviews of the effectiveness of wetland conservation where a "no net loss approach" has been adopted. Clearly there is a need for effective wetland conservation policies, though the implementation of few, if any, of Canada's current policies are seen to meet this standard. While biologists have struggled to answer the obvious question "Why is this the case?" most would agree that ultimately all conservation and protection of natural resources, including wetlands, is local in nature. They would also likely agree that more needs to be done to bring timely, accurate and reliable biological and economic information to decision makers at all levels of governance as the inevitable trade-offs are made in the use and non-use of wetlands and indeed every other natural resource in Canada.

Ecological function evaluation and analysis of quantity and economic value of wetland EGS is not a panacea for wetland conservation. In the face of competing values, attaching a dollar value to wetland benefits may not have any measurable impact on or change practices resulting in the decline in wetland quality/function or their outright removal. One reason is that many of the economic values are not traded in markets and hence there is a general ignorance of the value of wetlands to society. Increased social science and economic research can improve our

understanding of land and resource use and help find much-needed common ground. Such information will be critical to the development and adoption of sustainable and effective wetland policies in the future.

6. Conceptual and Methodological Challenges of Wetland Evaluation and Economic Valuation

Canada is an ecologically diverse country, from coastal salt marshes in the Maritimes, to Carolinian wetlands in southern Ontario, to prairie potholes, deltaic marshes and estuaries along the Pacific coast and vast expanses of fens and bogs and Arctic lowlands in the Far North. Ecological function is widely variable among wetland types within an ecozone. Further, geographic and climatic variability across a country as large as Canada further complicates achieving the goal of a common framework for evaluation.

Additionally, since by definition economic value of services from wetland function requires a human beneficiary, placing a dollar value on wetlands is problematic in the expansive non-settled areas of the country. Furthermore, an individual wetland may support a variety of ecological functions but only a subset of these functions may translate to EGS that have economic value. Adding to these challenges, there is a paucity of studies estimating the economic benefits of wetlands in Canada. This absence of case studies and analysis remains an obstacle to the development of a pan-Canadian framework and a subsequent best practices guide. Without information assessing the effectiveness of various practices, a best practices guide will need to draw on other data sources. With an appropriate research plan and investments here in Canada, improvements to the best practices guide will be possible over time.

Participants in CWR's 2020 workshop agreed that there was merit in the development of a guide to best practices in wetland evaluation, based on current knowledge that could be applied to Canadian wetlands regardless of location and wetland type. A best practices guide should embrace both ecosystem function evaluation and economic valuation of services and demonstrate how these activities differ; but, also the dependency of economic valuation on accessible and current biophysical data.

In order, however, for this evaluation/valuation framework to succeed, ecosystem services need to be measured quantitatively or qualitatively, using benefit relevant indicators which are grounded in biophysical sciences, and are also relevant to people. These indicators serve to guide the transition from biophysical modelling of functions through to ecosystem goods and services to the economic modelling that produces a dollar value. Fortunately, a great deal of work has already been done, not only in terms of methodologies for ecological function evaluation, but also in terms of the integrated approach to biophysical modelling and economic modelling. This applied research area is rapidly evolving highlighting the imminent need to take full advantage of the current state of wetland ecosystem function evaluation and economic valuation.

7. Best Practices for Function Evaluation and Services Valuation: The Overall Requirements

Once completed, the Canadian best practices guide for wetland function evaluation and economic valuation of benefits needs to be accessible, comprehensive and illustrative of best practices. It should identify research requirements and adopt an overall model that identifies all the key elements and their linkages in the evaluation and valuation process. Roughly speaking, this model should comprise the following sequence of elements and their transition: inputs, function, service, measurement and economic/other valuation.

The guide also needs to accommodate the considerable complexity inherent in evaluation and valuation needs and activities across Canada. The complexity starts with the fact that the drivers for change on the landscape are many, and for which the needed conservation and management strategies and solutions will also be different. This complexity features multiple users, including regulators, conservation planners, private sector consultants, resource sector companies and environmental impact assessment practitioners. Complexity is further driven by: a multitude of potential needs (inter alia conservation and protection; sustainable use; municipal planning; forest, agricultural and non-renewable resource development; public infrastructure; and, water quality and control); as well as the requirement to operate at various scales, from site-specific to landscape and national levels.

Additionally, adopting a cascade approach to the evaluation/valuation framework will provide a focus for better understanding the key elements and their interactions. Here a key source document is: Potschin-Young M, et.al 2018. *Understanding the role of conceptual frameworks: Reading the ecosystem service cascade*. Ecosystem Services 29:428-440. See Appendix 4: References and Information Sources.

8. Best Practices for Ecosystem Functions Evaluation and Valuation of Wetland Services – The Technical Road Map

The Project Team and workshop participants support the further development of a road map or table to capture the complexities of the guide development and accommodate the various operational requirements and circumstances of practitioners. Development of the road map began in the late summer of 2019 with inspiration from the publication by Bonnie L. Keeler et al 2012 entitled: *Linking water quality and well-being for improved assessment and valuation of ecosystem services*. Since then, with guidance from the Project Team and 2020 workshop participants, the current version of the road map has been updated to align with the following current international guides:

- The Common International Classification of Ecosystem Services (CICES) developed from the work on environmental accounting undertaken by the European Environment Agency and the United Nations Statistical Division
- Wetland Ecosystem Services Protocol (WESP) a standardized method currently in use by 5 Canadian provinces and a number of U.S. jurisdictions for rapidly assessing some of the important natural functions of wetlands

The road map (*attached to this annotated guide*) will include recommendations for best management practices and evaluation/valuation methods. It will also provide guidance as to how best to select the appropriate method for the purpose at hand. Examples of case studies may be of further assistance to users, as will sample entries. Where available, key ecological, economic and social data sources, such as inventories/indicators, should be identified. Further general guidance on how to use the guide for Evaluation/Valuation will include the following:

- Make explicit to practitioners the strengths and weaknesses of these approaches, tools and methods, including a caution on the limitations of relying on the valuation/evaluation of wetland services to inform decisions about their use and management.
- Identify, where possible, outstanding research needs across disciplines, their interactions in the guide and the methods to be employed in order to conduct both function evaluation and economic valuation.

- Use of Biodivcanada's toolkit offers the opportunity to strengthen the organization, content and comprehensiveness of the guide; further accommodate the complexity of need, use and scale; and adopt additional standardized and common language.
- Reference to contemporary mapping and remote sensing approaches, such as the European Union's Mapping and Assessment of Ecosystems and their Services (MAES), is recommended.

9. **Implementation Guide: 8 Steps** (refers also to road map to follow)
   In addition to the road map, a stepwise approach is also recommended as a means to guide project planning and implementation. Eight steps are proposed as follows:
   i. Defining the evaluation and/or valuation problem
   ii. Determining the scope of the project
   iii. Locating the project starting and end points
   iv. Identifying the requirements for each step
   v. Gathering existing and new data
   vi. Selecting analysis methods
   vii. Conducting the analysis
   viii. Communicating results

The following sections will be completed as part of the final guide:

10. **Science and Research Needs**
11. **Summary and Conclusions**
12. **Compendium of Information**
13. **List of Attachments**
14. **References**

Technical Road Map

Introduction and Purpose

The Project Team and workshop participants recommended a "road map" approach to capture the project complexities and accommodate the various requirements for a best practices guide. As noted earlier, development of the road map began in the late summer of 2019, with inspiration from a publication by Bonnie L. Keeler et al 2012. *Linking water quality and well-being for improved assessment and valuation of ecosystem services*. Since then, with guidance from the workshop, the current draft road map (below) has been updated to align with the following:

- The Common International Classification of Ecosystem Services (CICES), developed from the work on environmental accounting undertaken by the European Environment Agency and the United Nations Statistical Division
- Wetland Ecosystem Services Protocol (WESP), a standardized method currently in use by five Canadian provinces and a number of U.S. jurisdictions for rapidly assessing some of the important natural functions of wetlands

Table 2: Wetland Evaluation and Economic Valuation – A Guide to Best Practices

CICES Section	CICES Division	CICES Group	CICES Class (WESP terminology)	Ecosystem Services or Users	Benefit relevant indicators (examples)	Valuation methodology (examples)
Provisioning	Biomass	Wild plants for nutrition, materials or energy	Timber Harvest	support of wood products industries	harvestable timber volume	market value
			Harvest of Native Plants	* for hay * for harvest (grazing) by domestic animals * for horticultural use * for sustainable bioenergy production * for human consumption	area of suitable plant species	market value
Regulation & Maintenance	Transformation of biochemical or physical inputs	Mediation of wastes or toxic substances by living processes (Waste Assimilation)	Sediment & Toxicant Stabilization	Water Quality (water safe for: * human consumption * bodily contact * livestock watering * aquatic life * water clarity as amenity (aesthetics etc.) * safe for livestock * Water clarity as amenity (aesthetics etc.)	exceedance of criteria for suitability, toxicity, frequency & extent of downstream algal bloom occurrence # of water users, frequency & duration of water use	Stated Preference methods, replacement cost
			Phosphorus Retention			
			Nitrate Removal			

CICES Section	CICES Division	CICES Group	CICES Class (WESP terminology)	Ecosystem Services or Users	Benefit relevant indicators (examples)	Valuation methodology (examples)
	Regulation of physical, chemical and biological conditions	Regulation of baseline flows and extreme events	Water Storage	Flood control * Crop production	# and value of at-risk structures, measures of water volumes stored	Damage cost, Hedonic price method
			Tidal Surge Interception			
			Stream Flow & Temperature Support	Water Quantity * to support aquatic life * for domestic consumption * for recreation * for livestock * for crop irrigation * as amenity (aesthetics etc.) * for domestic consumption * for recreation * for livestock * for crop irrigation * as amenity (aesthetics etc.)	accessible water (water volume, flow rate, depth, elevation), # of water users, frequency & duration of use	marginal value of items dependent on water quantity; replacement cost Hedonic price method
		Lifecycle maintenance, habitat and gene pool protection	Aquatic Primary Productivity	to support ecosystems & cultural values/ uses (non-consumptive use value) * Crop production	net gain in C/m2/ year (onsite)	Stated Preference methods can have “market “prices (carbon tax can be a price)
			Organic Carbon Export		net gain in C/m2/ year (downstream)	
			Invertebrate Habitat		multiscale species richness, extinction risk, habitat area & structure	
			Fish Habitat			
			Amphibian & Turtle Habitat			
			Waterbird Habitat			
			Habitat for Other Wetland-dependent Birds			

CICES Section	CICES Division	CICES Group	CICES Class (WESP terminology)	Ecosystem Services or Users	Benefit relevant indicators (examples)	Valuation methodology (examples)
			Keystone Mammal Habitat (beaver, muskrat, moose)			
			Plant Biodiversity			
			Pollinator Habitat	crop production	rate of successful pollination x area, effect of pollination on yields	Marginal crop value attributable to pollination
		Regulation of atmospheric composition & condition	Carbon Accumulation Rate	protection of global climate	net gain in C/m2/ year (onsite)	Social cost of carbon
		Regulation of soil quality (retention & formation)	Permafrost Protection	* to support local infrastructure * to support local ecosystems * to protect global climate * to support crop production	rate & extent of permafrost loss (thermokarsting)	Damage costs avoided, Hedonic price method
		Regulation of wildfire spread	Wildfire Resistance		degree of risk reduction x value of assets at risk	
Cultural	Direct, in-situ, and outdoor experiential interactions with living systems that depend on presence in the outdoor setting		Recreational & Amenities Values (Public Recognition & Use)	Consumptive Recreation (hunting, fishing)	# of hunting days or trips reliant on the specific wetland or complex, impacts of waterfowl population changes on trips etc.	Travel cost model, stated preference methods
				Non-consumptive Recreation & Use (hiking, wildlife observation, etc.)	# of birdwatching trips or days reliant on the specific wetland or complex	
				Scenic/Aesthetic Values	# of homes near wetland or complex that could be impacted by the wetlands	Hedonic price method
				Heritage/Legacy, Research, Education Values		

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