Ecosystem Services and Wetlands: A Workshop Synopsis

June 8, 2017 | Executive Royal Hotel, Leduc

Hosted by ABMI

ABMI

IT'S OUR NATURE TO KNOW.

Prepared by:
Sagewood Communications Solutions Ltd.

Contents

Background

Launched in 2012, the *Ecosystem Services Research and Innovation Roadmap*, a province-wide initiative, was developed to assess ecosystem services across Alberta, understand how they are affected by human activities and incorporate this knowledge into market-based instruments for environmental management. The *Roadmap* sets the direction for innovation and has formed the basis for subsequent efforts to develop and implement an ecosystem services approach to resource management in Alberta.

Introduction

On June 8, 2017, as part of the broader dialogue taking place around ecosystem services, and in an effort to improve land-use decision making processes by connecting wetland function and ecosystem services, the Alberta Biodiversity Monitoring Institute (ABMI) hosted an "Ecosystem Services and Wetlands" workshop attended by 38 individuals with broad representation from provincial and municipal government, conservation organizations, WPACs, researchers (including modeling specialists) agricultural organizations and municipal associations.

Many of the workshop attendees have contributed to the ecosystem services discussion in varying degrees over the years, and all participants have been involved, in different capacities, in planning and management decisions for conservation and restoration of wetlands in the white areas of Alberta. A list of workshop participants is included in Appendix A.

The forefront of this document provides a concise overview of the workshop, including the introductory and contextual presentations from Alberta Innovates, ABMI, Alberta NAWMP Partnership, Ducks Unlimited Canada and Native Plant Solutions, and Alberta Environment and Parks, as well as the key points from the subsequent facilitated question discussions. For reference, the complete workshop presentations are provided in the appendices.

Objectives

The workshop presented the opportunity for people from various sectors who are engaged in land-use planning and decision making, and wetland conservation/restoration work at various levels, and who are interested in knowing more about and/or advancing the wetlands/ecosystem services correlation, to meet and discuss the workshop topic face-to-face.

The intent of the workshop was to encourage participants to discuss and gather their feedback on:

- Building a common understanding of existing methods and models that assess ecosystem services related to wetlands;
- Identifying constraints and opportunities to using an ecosystem services approach to wetland management; and
- Determining next steps for using ecosystem services assessments in decision making and for successful implementation of ecosystem services markets.

Ultimately, the workshop provided a forum for engaged individuals to contribute to a discussion that will help determine the next steps to developing and supporting a wetland management system in Alberta using an ecosystem services approach.

Prospective Outcomes

ABMI intends to use the feedback and recommendations from workshop participants in the development of:

- Recommendations for government – in terms of policy and land-use planning implementation;
- A subsequent report on a proposed ecosystems services approach for wetlands;
- Brochures and fact sheets regarding "how to" implement an ecosystems services approach for wetlands; and
- Potential next steps for the project team (e.g. development of subsequent pilot projects, case studies and/or educational materials).

Presentation 1: Ecosystem Services Approach to Resource Management

Carol Bettac, Alberta Innovates

Carol set the stage for the day's discussions by providing an overview of ecosystem services (the benefits humans receive from nature), ecosystem services and biodiversity markets (markets in which the transactions take place with the goal of improving or maintaining environmental quality) and how these market approaches have shown to cause positive changes in land-use management, demonstrating alignment between and bringing benefits to individuals, communities and businesses.

She explained Alberta Innovates' role in and summarized the multi-dimensional, multi-stakeholder, cross-sector approach (Ecosystem Services and Biodiversity Initiative) that has been taken to support and carry out the broad scope of work in the area of ecosystem services over the past several years. This approach facilitated the development of the Ecosystem Services Roadmap (2012) and the establishment of the Ecosystem Services Biodiversity Network and working group (2015), which form the basis for supporting ecosystem services and biodiversity market innovation and capacity in Alberta going forward.

Led by various Network partners (e.g. ABMI, Silvacom, Innotech, Land Stewardship Centre) key efforts to date have included identifying and reviewing data and information systems; understanding assessment tools and protocols; understanding market infrastructure and the socioeconomics associated with ecosystem services; working with the government to inform policy; capacity building and effectively engaging stakeholders. The information and feedback gathered through these efforts will enable the development of focused pilots, such as the ecosystem services and wetlands project, which will help identify ways to incorporate an ecosystem services approach to wetland management (restoration and protection) in the future.

Next steps include further stakeholder engagement, expanding and formalizing the Network to continue work and establish pilot projects in key areas such as wetlands, grasslands, caribou habitat, etc. that will support the creation of ecosystem services and biodiversity markets in Alberta.

Presentation 2: Assessing Ecosystem Service Benefits of Wetlands

Carrie Selin, Alberta Biodiversity Monitoring Institute

Carrie provided an overview of the "Assessing Ecosystem Service Benefits of Wetlands" project, which aims to improve decision making processes by connecting wetland ecosystem function and ecosystem services. Supported by multiple partner organizations (Alberta NAWMP Partnership, Land Stewardship Centre, ABMI, Silvacom, GoA, University of Alberta, Alberta Innovates, Ecosystem Services and Biodiversity Network) this project aims to demonstrate how wetland-related ecosystem services approaches can be used to deliver economic, environmental and social outcomes. Once completed, the project will enable a better understanding of: the full impacts of management actions made on the landscape impact ecosystem services; multiple ecosystem services benefits at various scales; where to strategically invest (i.e. biodiversity, water storage, water purification, etc.); competing mandates and identifying trade-offs.

The project builds on a significant amount of work already done or currently underway by numerous organizations and experts in this field (e.g. Alberta Environment and Parks, Alberta Land Institute, ABMI, Alberta Innovates, Alberta NAWMP Partnership, and others). As part of this project, this workshop is intended to gather input from various perspectives and then develop recommendations that will enable informed decisions about wetland management using an ecosystem service approach. Going forward, the project will also incorporate wetland restoration as the tangible example used to demonstrate ecosystem services and biodiversity markets, followed by the development of targeted communications to key audiences.

Carrie's complete presentation is available in Appendix B.

Presentation 3: Setting Regional Wetland Management Objectives

Terra Simieritsch, Alberta NAWMP Partnership

Terra gave a high-level overview of the Alberta NAWMP Partnership and then presented on their work which, using a phased approach, focused on identifying and understanding the role that regional wetland management objectives could play in planning and decision making.

Alberta NAWMP conducted a scan of Alberta legislation, policies, frameworks and strategies that included or could include wetland management objectives; interviewed knowledge leaders; conducted a jurisdictional review; drafted specific recommendations and presented to key stakeholders.

Outcomes of this scan determined the term "regional wetland management objective" is ambiguous and complex; important and extensive work on wetland management objectives is already taking place through WPACs and other organizations; a functions-based approach needed to be included in addition

to an acreage-based approach; ecosystem services are a means to engage stakeholders in the development of wetland management objectives by creating an understanding of the values that wetlands provide.

Next steps consisted of a multi-stakeholder workshop intended to assess the utility of setting and then strengthen the case for setting wetland management objectives, identify specific opportunities within Alberta's LUF Regional plans, Municipal Plans and WPAC plans, and examine the ability of models to support wetland planning needs.

Outcomes of the workshop: An agreed-upon definition for "regional wetland management objective" (defined as: a specific and measurable target to identify wetland quantity, quality and distribution necessary to achieve ecosystem service outcomes); a better understanding of how setting regional wetland management objectives would work for particular groups; a discussion of how models can be used to set or support regional wetland management objectives.

Next steps to carrying this initiative forward include: a call for leadership, a nested approach, specific modelling recommendations, and implementation at a pilot scale. Reports on this work are available from Alberta NAWMP. Terra's complete presentation is available in Appendix C.

Presentation 4: A Review of Models and Tools Used to Assess Wetland Ecosystem Services

Ducks Unlimited Canada and Native Plant Solutions

Lisette Ross, with Native Plant Solutions, began the presentation by providing a detailed outline of the Ducks Unlimited Canada/Native Plant Solutions (DUC/NPS) project to review various tools and models that could be used to assess and value wetland ecosystem services in Alberta. Guided by well-defined terms of reference and clearly established wetland-focused criteria for model/tool evaluation, the project methodology included a literature review and review of approaches, interviews with model/tool developers, and a jurisdictional investigation. Following the initial literature review, based on established criteria (eight specified wetland ecosystem services), a total of thirteen (out of 24) tools and models were assessed; each had varying degrees of skill-level requirements, documentation, data input requirements, scale, applicability to wetlands and applicability to Alberta.

Justin Vitt, with Ducks Unlimited Canada, gave a high level overview of the models/tools that were reviewed, then spoke in detail about the most promising models/tools (as recommended by DUC/NPS) for use in the Alberta landscape along with their data requirements and limitations, along with a brief mention of those models/tools that are not recommended and why.

Lauren Bortolotti, with Ducks Unlimited Canada, concluded the first portion of the presentation with a summary of the broad patterns observed, identified important characteristics of and data requirements for the most promising models, and shared take home points and recommendations from the model/tool review and assessment. Final recommendations included: prioritize the key wetland ecosystem services that are most important to Alberta and focus efforts there; no single tool should be

considered for a comprehensive wetland ecosystem service valuation; choose wetland-specific models that are designed to address prairie wetlands; identify the scale and resolution required and determine if you have the data available to support that; consider the tool user when selecting models; consider the model output (e.g. qualitative vs. quantitative); choose models that do a good job of measuring biophysical data, not just economic value.

Justin followed with a summary of the outcomes of their jurisdictional review. This part of the project involved contacting four different jurisdictions in which wetland ecosystem service valuation has been developed as a tool or applied on the landscape in association with planning or policy. The jurisdictions contacted included: Minnesota (Minnesota Restorable Wetland Prioritization Tool), Credit Valley Conservation (economic valuation of wetland ecosystem services), North Dakota (CEAP/ILM), and Delaware (statewide wetland valuation using InVEST). This review provided insight into limitations and challenges, successes and learning opportunities related to the application and implementation of assessment models in other regions. Based on this jurisdictional review the key recommendations for successful application of models included: pair ecosystem service valuation with strong wetland policy that encourages wetland restoration; proceed with both internal and external reviews using expert opinion; track usage to determine if implementation has been successful or if modifications are required; weigh opportunities versus limitations of economic valuation; and ensure the model/tool can be used by more than just experts.

The full report prepared by Ducks Unlimited Canada/Native Plant Solutions, "Wetlands and their benefits: review and synthesis of tools and models assessing wetland ecosystem services" is available at: http://ecosystemservices.abmi.ca/resources/publications/ The complete Ducks Unlimited Canada/Native Plant Solutions presentation is included in Appendix D.

Presentation 5: Ecosystem Services and the Alberta Wetland Policy

Thorsten Hebben, Alberta Environment and Parks

Thorsten presented an overview of project(s) undertaken in Alberta to investigate the operationalization of an ecosystem services approach within the government of Alberta, and in particular, highlighted outcomes of the 2011 Ecosystem Services Approach Pilot on Wetlands.

He identified the challenges associated with implementing an ecosystem services approach from a policy perspective. This includes: the diversity of wetland classes and their respective benefits, and their spatial variability/distribution (including the issue of wetland loss); the need to understand, assess and incorporate different stakeholder perspectives; differential weighting; legislative and regulatory limitations, and ongoing questions around the financial aspects of ecosystem services.

Additional considerations include: determining wetland value – wetlands are highly diverse in form, function, use, and distribution across the province – they are not all of equal value; translating wetland function to benefit from a landowner perspective (a confined spatial scale); ongoing cultural hurdles

associated with public perceptions of the value of wetlands; and an incomplete understanding of regulatory accountabilities under the provincial Water Act.

Looking forward, the ecosystem services approach will help landowners (specifically agricultural producers) to understand and evaluate wetland functions/values in meaningful economic terms. But incorporating wetland benefits into policy will require multiple conversations with multiple stakeholders to enable a better understanding of how function translates to value.

Thorsten's complete presentation is available in Appendix E.

Facilitated Discussions

For these discussions, participants were divided into five groups. In each group, participants were asked to discuss and respond to four questions, the answers to which will be fundamental to helping ABMI and the project partners continue their work to determine what is required to support a wetland management system in Alberta using an ecosystem services approach.

An individual at each table recorded their respective group's responses and discussions. The input from the five groups on each of the four questions has been consolidated and summarized below.

Question 1

Background

Although the Alberta Wetland Policy (2013) and Alberta's Land-Use Framework provide opportunities to implement an ecosystem services concept, and for some time now attempts have been made by numerous groups to advance the concept, it still remains a "concept" rather than a specific "approach" for environmental management.

Considering Alberta's wetland management policy and regional planning processes, what are the strengths and/or opportunities for creating a comprehensive ecosystem services approach?

- The Ecosystem Services Policy Framework currently under development will provide guidance for implementation.
- Economic valuation is key, but not the only piece; there are opportunities to incorporate both economic and non-economic value of wetlands.
- An ecosystem services approach may be more meaningful and relevant if implemented on a smaller scale/more local; this approach may result in greater engagement.
- The Alberta Wetland Policy and the Land Use Framework enable an ecosystem services approach.
- A Wetland Management Framework would provide consistency of approach, measurable objectives, scale and how this all ties into ecosystem services.

How can regional planning processes be strengthened using an ecosystem services approach?

- Develop communications tools; use ecosystem services champions; use programs such as Multisar and ALUS.
- There is an opportunity for ecosystem services markets, but there is also risk if the government is the only buyer.
- There is need for government direction to implement an ecosystem services market i.e. quality of credits, how payments are made, what is ethical, etc.

Question 2

Background

Understanding wetland functions, including conditions of the wetlands to provide those functions, is a necessary first step in an ecosystem services assessment. Various assessment methods (models) are available and used by decision makers to gather, organize and understand complex information related to wetland function in order to better understand the impact of management decisions.

What are the gaps and/or constraints associated with using assessment methods (models) for wetland conservation and restoration decision making.

- Wetland inventory: a complete wetland inventory that includes cultural and indigenous perspective, economic valuation in an Alberta context; the potential for restoration, and a drained wetland inventory.
- Data: it must be accurate, accessible and freely available.
- Models: open source.
- Scale: regional versus local – they are related but require different approaches.
- Communication: will help create buy-in among stakeholders; plain language model/tool documentation and user manuals are also needed.
- Engagement: data sharing; providing input and validation throughout the process.
- Experience and capacity: there are varying levels of experience and capacity among user groups (e.g. municipalities, WPACs, other smaller organizations).
- Assessment approach: the "function" approach is different from the "valuation" approach.

Question 3

Background

An ecosystem services-based wetland management system will help decision makers establish priorities for wetland avoidance, mitigation and restoration based on human benefits. An ecosystem services approach to support wetland management includes key indicators and models (or methods) that evaluate or assess those indicators. Data requirement insights are also desired that will lead to effective implementation of the Alberta's wetland policy and programs.

What are the recommendations or next steps for moving forward in building an ecosystem services approach to wetlands management as it relates to:

a. **Information management system (data, inventories):**

- More open source data needs to be available.
- Provide access to web-based models (reduces storage issues) and a desktop version for more intensive modeling; enables multiple users to input data.
- Set data, inventory and modeling standards; consistency and scalability are important.
- Establish a repository of available data that everyone can use.
- Develop a flowchart/decision tool of which model to use.

b. Assessment methods/models (identify what tool, how it can be applied, and at what scale):

- A central "voice" to identify the most appropriate models to use.
- Take a landscape approach to modeling.
- Choose model according to purpose and scale needed.
- Assess and quantify gains from enhancing existing wetlands as well.
- Cultural models are challenging; work with people with expertise in socioeconomics.

c. Communication and stakeholder engagement (building a better understanding of ecosystem services):

- Develop a collective education program with a roadmap that prioritizes research needs.
- Target communications to rural and urban audiences.
- Use citizen science to validate models.
- Create a communications strategy to explain the value of ecosystem services so all stakeholders understand and can commit to being involved; language used will be important.
- Build engagement that speaks to different values; for example, dollar value may not be the most appropriate way to convey the "value" of ecosystem services.

Question 4

What are the principles that will enable an ecosystem services approach to wetland management?

- Open access to markets.
- Value traditional (indigenous) knowledge.
- Openness and honesty will build buy-in and collaboration.
- Stakeholders need guidance; do not overwhelm people and expect immediate understanding.
- Stakeholder communication must be a process; two-way communication.
- Consider multiple ecosystem services simultaneously; use a landscape approach.

Closing Remarks

When considering ecosystem services, we are further along with wetlands and understanding their benefits than we are with, for example, forests, grasslands or peatlands. While this workshop has focused on ecosystem services relative to wetlands, consideration should also be given to the broader ecosystem services roadmap – where multiple ecosystem services on the landscape are considered (e.g. those attributed to grasslands, forests, peatlands, etc.).

Moving forward participants' continued involvement is encouraged in the wetland and broader ecosystem services conversation, especially in the areas of understanding how function translates to benefit and value, which ultimately provides the framework in which an ecosystem services approach can be applied in order to implement this approach in land-use planning and management.

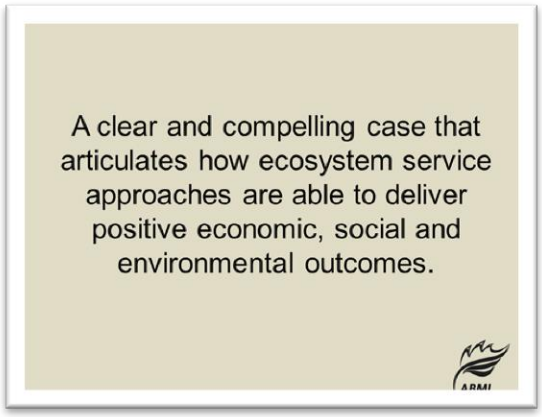
Appendix A: Workshop Participants

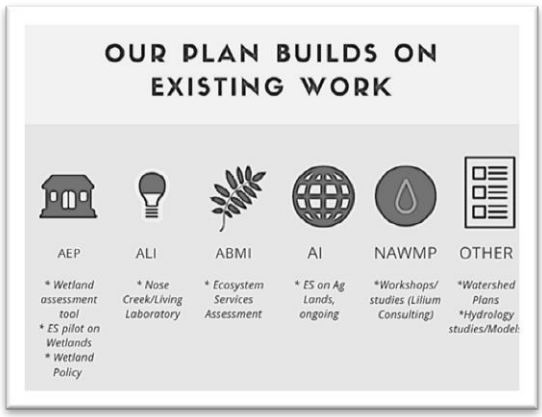
Name	Organization	Sector
Achyut Adhikari	Edmonton	Municipal
Caroline Bampfylde	AEP	Government
Tasha Blumenthal	AAMDC	Municipal
Fiona Brody	CSWG	Agriculture
Susanna Bruneau	BRWA	WPAC
Christine Campbell	ALUS Manager	ALUS
Megan Casey	ALUS Lace Ste Anne	Municipal
Shari Clare	Fiera Biological	Consulting
Janet Dietrich	AEPA/AAF	Government
Lindsye Dunbar	WSGA	Agriculture
Cathie Erichsen Arychuk	Vermillion	Municipal
Craig Harding	NCC	ENGO
Fred Hays	ABP	Agriculture
Paul Jungnitsch	AAF	Government
Agnieszka Kotowska	City of Edmonton	Municipal
Ken Lewis	ALUS Red Deer	Municipal
Melissa Logan	NSWA	WPAC
Paplo Lopez	Calgary	Municipal
Glenn Mack	Fish and Wildlife, E&P	Government
Sandra McMillan	AEP	Government
Aaron Petty	Modeling Team Lead	Government
Karen Raven	AAF	Government
Warren Robb	DUC	ENGO
Tracy Scott	DUC	ENGO
Carol Steggan	Calgary	Municipal
Peg Strankman	Forage Network	Agriculture
Walter Suntjens	ABP	Agriculture
Tim Walls	Calgary	Municipal
Norm Ward	WSGA	Agriculture
Matthew Wilson	AEP	Government
Wanhong Yang	University of Guelph	Researcher

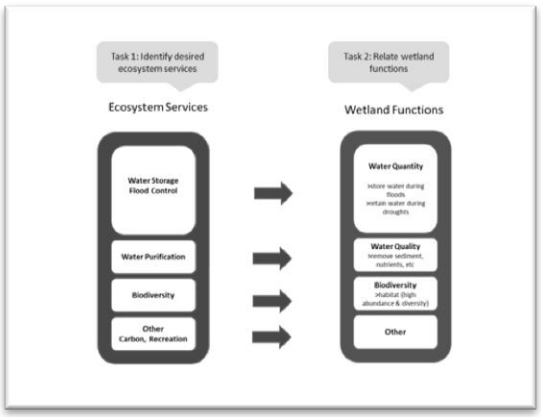
Project Team	
Toni Anderson, Silvacom	Carrie Selin, ABMI
Carol Bettac, AI	Terra Simieritsch, Alberta NAWMP
Peter Boxal, U of A	Marian Weber, AI
Tom Habib, ABMI	Justin Vitt, DU & NPS
Lauren Bortolotti, DU & NPS	Lisette Ross, DU & NPS

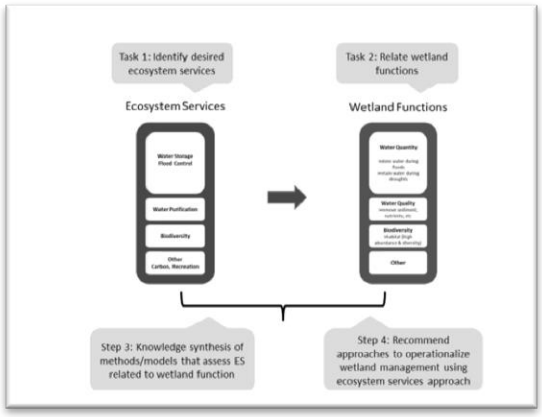
Appendix B: Assessing Ecosystem Service Benefits of Wetlands

A presentation by Carrie Selin, ABMI








Task 1: Identify desired ecosystem services
Task 2: Relate wetland functions
Ecosystem Services
Wetland Functions
Water Storage Flood Control
Water Purification
Biodiversity
Other Carbon, Recreation
Water Quantity
Water Quality
Biodiversity
Other
Step 3: Knowledge synthesis of methods/models that assess ES related to wetland function
Step 4: Recommend approaches to operationalize wetland management using ecosystem services approach


Next steps
• Develop recommendations that will enable informed decisions about wetland management using an ecosystem service approach.
• Use wetland restoration as the tangible example to demonstrate ecosystem services and biodiversity markets
• Create communication tools for targeted audiences
ABMI

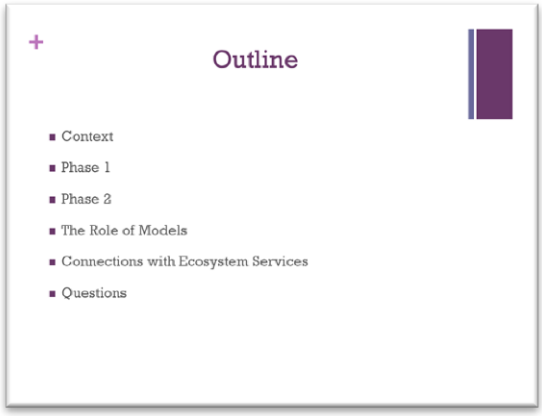

Partners and advisors
Alberta NAWMP Partnership
Land Stewardship Centre
ABMI
silvacom
Alberta
UNIVERSITY OF ALBERTA
ALBERTA INNOVATES
ECOSYSTEM SERVICES + BIODIVERSITY NETWORK

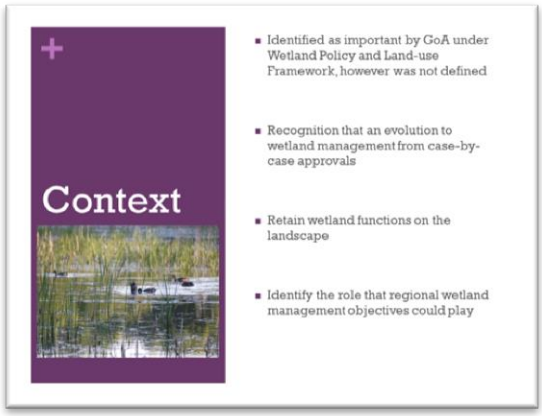

Questions?
ABMI

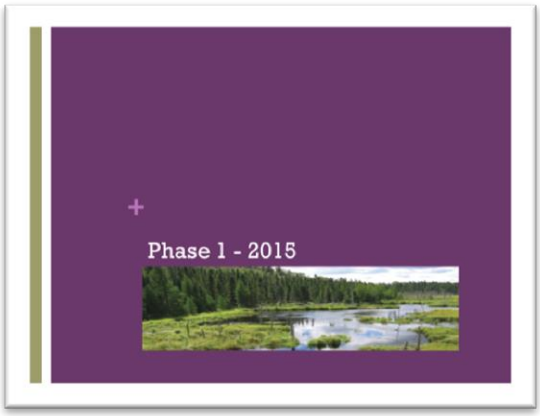
Appendix C: Setting Regional Wetland Management Objectives

Project Overview and Linkages to Ecosystem Services

A presentation by Terra Simieritsch, Alberta NAWMP Partnership







Watershed Planning and Advisory Councils

BBWMP Wetland Outcomes and Objectives Examples

- *"existing wetland complexes including associated upland areas and ephemeral wetlands are kept intact, restored, ecologically functional, appreciated and valued"* (general outcome)
- *"no further net loss of wetland area or wetland number"* (measurable objective)
- *"the percentage of Bow Basin municipalities with wetland conservation guidelines and/or bylaws on no further net loss of wetland area"* (measurable objective)

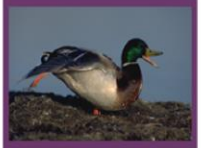
Municipalities

- City of Calgary
  - No net loss for Environmental Reserve Wetlands
  - No specific objectives
- City of Edmonton
  - Wetland Protection Planning and Process report
  - Main objective and support actions
- Strathcona County
  - No net loss goal
  - Mitigation activities
- Parkland County
  - Environmentally significant areas management considerations

Knowledge Leader Interviews

- Inform the why, who ,where and how of setting regional wetland management objectives in Alberta
- 14 individuals
- Common themes, differences of opinion and specific ideas represented

Jurisdictional Review



- Learn from experiences elsewhere
- Function and Acreage based
- Primarily US based examples
- Multi-stakeholder groups

Ecosystem Services of Wetlands

- One Knowledge Leader chosen for ecosystem service expertise
- Wetland ecosystem services noted as a means of engaging stakeholders in wetland management
- Ecosystem services provide an understanding of the values wetlands provide
- Planning a process from an ES perspective could also allow for a means of engaging multiple departments for them to make decisions together (holistically)
- Knowledge Leaders noted synergies with this project and ES projects that were starting up at the time

Next Steps

- Define key terms
- Decide who key players are and process for engagement
- Develop a consistent process
- Choose scale and pilot areas
- Determine data needs and means of compiling data
- Develop accountability systems
- Choose an evaluation cycle
- Workshop ideas with key stakeholders

Phase 2 - 2016

Workshop

- Multi-stakeholder workshop
- To assess the utility of setting regional wetland management objectives in Alberta
- Strengthen the case for setting objectives
- Identifying specific opportunities within the AB LUF Regional plans, Municipal Plans and WPAC Plans
- Gather people to form key cross-sector relationships
- Examine the ability of models to support wetland planning needs

Definition

A specific and measurable target to identify wetland quantity, quality and distribution necessary to achieve ecosystem service outcomes

Break-out Group Discussions (sector specific)

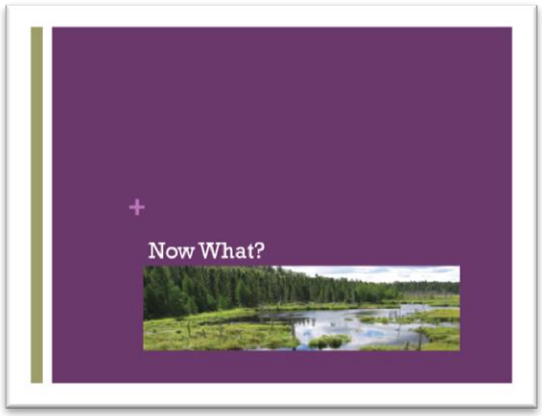
- Why would setting regional wetland management objectives be important to your group and what could it accomplish?
- Where would regional wetland management objectives best fit into your group's planning or policy initiatives? Where would it not fit in?
- Who would key players in your group be for setting regional wetland management objectives?
- Are there connections and potential opportunities for setting objectives at the provincial/regional, municipal and watershed levels? (If so how do we facilitate this and avoid overlap?)

How do models fit into all of this?

- Models as tools to set or support regional wetland management objectives
- Help us better understand complex systems
- Can allow us to look at future conditions and gain outputs that give us information for planning
- Help us make decisions based on whether or not we like the predicted future conditions

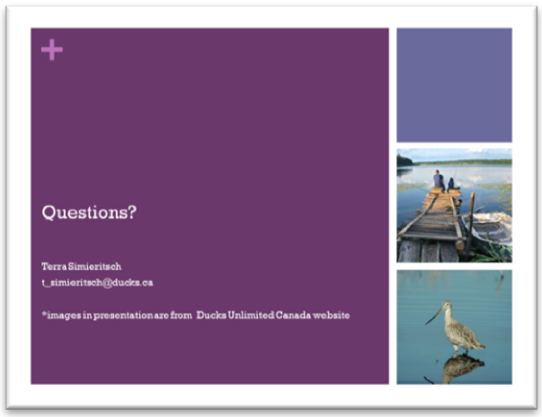
Conclusions

- Call for leadership (authority and accountability)
- Interest in a nested approach and partnerships
- Scope out tools to create objectives
- Host brainstorming sessions with expert groups
- Identify pilot areas
- Specific modelling recommendations



Next Steps

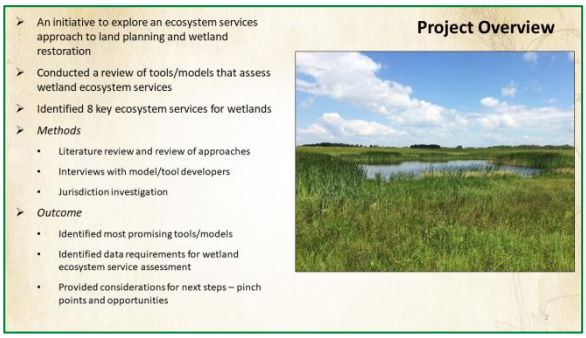
- Positive signals that this concept is of interest
- Needs leadership
- AB NAWMP decided to engage with ABMI to focus on furthering our knowledge on models and methods of assessing wetland ecosystem services
- Models have the potential to be the "how" for setting regional wetland management objectives
- Incorporate our knowledge into regional planning at a pilot scale

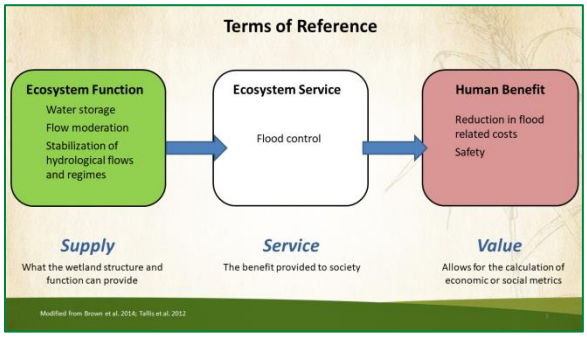


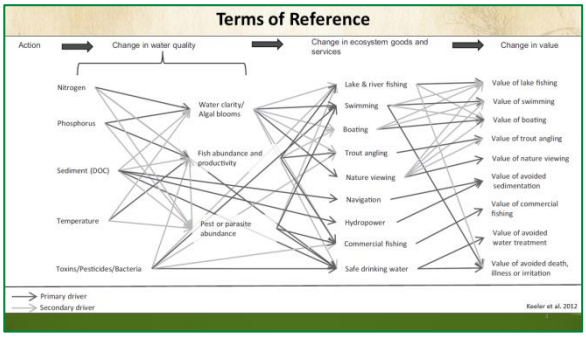
Appendix D: Wetlands and Their Benefits

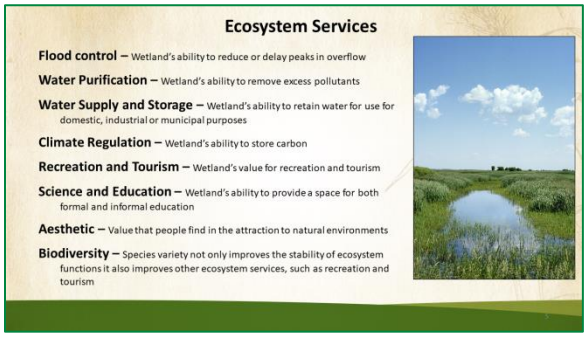
Review and synthesis of tools and models assessing wetland function and ecosystem services

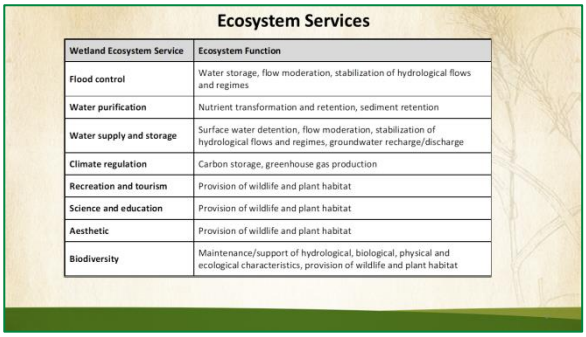
Presented by Native Plant Solutions and Ducks Unlimited Canada

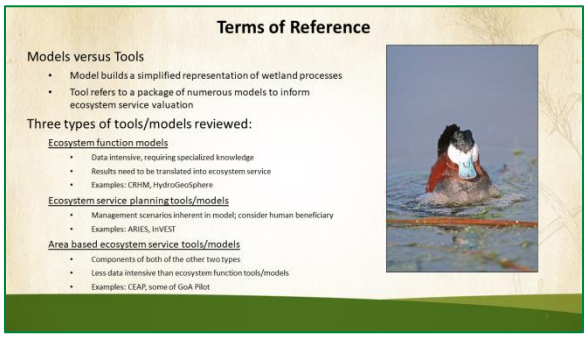


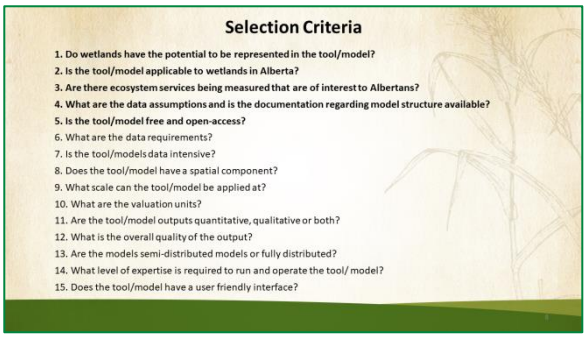












Initial List of Tools/Models

24 tools/models initially identified

- Cold Regions Hydrological Model (CRHM)
- Soil and Water Assessment Tool (SWAT)
- Integrated Modelling for Watershed Evaluation of BMPs (IMWEBs)
- 2011 Government of Alberta Ecosystem Service Pilot
- Alberta Industrial Heartland
- Alberta Biodiversity Monitoring Institute Water Purification
- Alberta Biodiversity Monitoring Institute Biodiversity
- Wetlands Component of the Conservation Effects Assessment Project (CEAP)
- Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST)
- Artificial Intelligence for Ecosystem Services (ARIES)
- Social Values for Ecosystem Services (SolVES)
- Minnesota Restorable Wetland Prioritization Tool
- A Landscape Cumulative Effects Simulator (ALCES)
- Multiscale Integrated Models of Ecosystem Services (MIMES)
- Ecosystem Valuation Toolkit (EVT)
- Ecosystem Service Valuation (ESV)
- Advanced Terrestrial Ecosystem Analysis and Modelling (ATEAM)
- Costing Nature
- Wildlife Habitat Benefits Estimation Toolkit (WHBRET)
- HydroGeoSphere
- DeNitrification-DeComposition (DNDC)
- Toolkit for Ecosystem Service Site-based Assessment (TESSA)
- Agricultural Policy/Environmental Extender (APEX)
- Wetland Ecosystem Services Model Prototype
- Alberta Wetland Rapid Evaluation Tool – Actual (ABWRET – A)

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Summary of Tools/Models

Tool / Model	Flood control	Water purification	Water supply	Climate regulation	Recreation and tourism	Science and education	Aesthetic	Biodiversity
CRHM	■	■	■					
SWAT	■	■	■					
IMWEBs	■	■	■					
2011 GoA	■	■	■	■				
ABMI		■						■
Industrial Heartland	■							
CEAP	■	■	■	■				■
InVEST		■	■	■	■			
ARIES	■	■	■	■			■	■
SolVES					■	■	■	
MN Wetland Tool		■						■
HydroGeoSphere	■	■	■					
DNDC				■				

Ecosystem Services

Flood Control – Wetland's ability to reduce or delay peaks in overflow

Water Purification – Wetland's ability to remove excess pollutants

Water Supply and Storage – Wetland's ability to retain water for use for domestic, industrial or municipal purposes

Climate Regulation – Wetland's ability to store carbon

Recreation and Tourism – Wetland's value for recreation and tourism

Science and Education – Wetland's ability to provide a space for both formal and informal education

Aesthetic – Value that people find in the attraction to natural environments

Biodiversity – As a supporting service, species variety not only improves the stability of ecosystem functions it also improves other ecosystem services, such as recreation and tourism

Flood Control, Water Supply and Storage

Tool / Model	Flood control	Water purification	Water supply	Climate regulation	Recreation and tourism	Science and education	Aesthetic	Biodiversity
CRHM	■	■	■					
SWAT	■	■	■					
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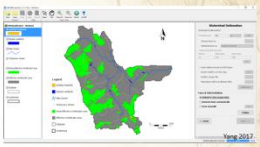
2011 GoA	■	■	■	■				
ABMI		■						■
Industrial Heartland	■							
CEAP	■	■	■	■				■
InVEST		■	■	■	■			
ARIES	■	■	■	■			■	■
SolVES					■	■	■	
MN Wetland Tool		■						■
HydroGeoSphere	■	■	■					
DNDC				■				

Flood Control, Water Supply and Storage

- Various options
  - Ranging from simple area-based models to hydrological models
- Generally tools/models do not distinguish between flood control and water supply
  - GoA Pilot is an exception
- Nine tools/models reviewed
  - CRHM, SWAT, IMWEBs, GoA Pilot, Industrial Heartland, CEAP, InVEST, ARIES, HydroGeosphere
- Most promising
  - CRHM, IMWEBs, GoA Pilot, CEAP

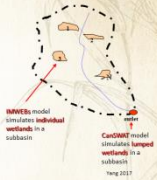
Integrated Modelling for Watershed Evaluation of BMPs (IMWEBs)

- Assessment of BMP effects on both water quantity and quality at multiple scales (location/field/farm/watershed)
- Simulate BMPs related to:
  - Crop management; fertilizer management; tillage management; wetlands (in development)
- Incorporates multiple hydrologic processes
  - Climate; snow and frozen soil; water balance and variation; sediment balance and variation; plant growth; nutrient balance and variation
- Data inputs
  - GeoSpatial data (DEM, land use, wetland inventory, soil, etc.)
  - Hydroclimate data (precipitation, temperature, etc.)
  - BMP data
  - Model parameters



Integrated Modelling for Watershed Evaluation of BMPs (IMWEBs)

- IMWEBs output
  - Water quality: concentration and deposition of nitrogen, phosphorus, and sediment
  - Water quantity: water volume, surface area and average depth
  - Additional: Evapotranspiration, groundwater recharge
  - Can be aggregated to different levels of scale (individual wetland, subbasin, watershed)
  - Can be viewed at user defined time interval (hourly, daily, monthly, yearly)
- Benefits
  - Simulates individual wetlands
  - Capable of simulating changes to effective and non-effective contributing areas
- Drawbacks
  - Detailed supporting documentation not currently available



Cold Regions Hydrological Model (CRHM)

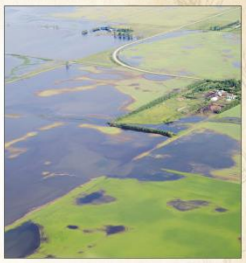
- Simulate hydrological processes in cold regions of Canada
- Prairie Hydrological Model (PHM) was developed from CRHM for hydrological process simulations in the prairie regions of Canada
- Incorporates multiple hydrologic processes
  - Snow distribution by wind; snow and rain interception by wind; sublimation; snowmelt; infiltration into frozen and unfrozen soils; water movement along hillslopes; evaporation; evapotranspiration; radiation exchange; groundwater flow; and streamflow hydraulics
- Data inputs
  - GIS data (DEM, land cover, wetland inventory, surficial geology, hydrology)
  - Meteorological datasets
  - Hydrometric datasets
  - Soil moisture datasets
  - Snow survey datasets

Cold Regions Hydrological Model (CRHM)

- CRHM Output
  - Water quantity estimates for small to medium sized watersheds
- Benefits
  - Models "spill and fill" dynamics
  - Simulates changes to contributing areas
  - Developed for cold regions
  - Applied in Vermillion River Watershed (Pomeroy et al. 2012) and Smith Creek Watershed (Pomeroy et al. 2014).
- Drawbacks
  - Requires advanced skill to use
  - Would require translation from hydrological terms to ecosystem service

2011 GoA Wetland ES Pilot – Flood Control

- Flood control index using a GIS modelling approach
  - Used LiDAR, land cover dataset
- Flood control index based off seven predictor variables
  - Water storage capacity of the wetland
  - Amount of impervious surfaces in the wetland catchment
  - Wetland catchment to wetland ratio
  - Amount of wetland subwatershed comprised by upslope wetlands
  - Wetland position in watershed & subwatershed
  - Wetland is connected to surface waters through natural or artificial drainage systems
  - Subsurface storage potential
- Benefits
  - Specific to flood control
  - Uses more than just wetland storage capacity
  - Good approach to simplify a complex process
- Drawbacks
  - Qualitative score



2011 GoA Wetland ES Pilot – Water Supply

- Estimate of the water storage capacity of wetlands using existing water in wetlands and storage capacity if wetlands were full
  - Volume-area relationship to estimate existing volume
  - Used LiDAR to estimate the potential additional storage using the elevation of the boundary of the wetland
- Estimate for the volume of water
  - Results summarized by size, permanency, etc.
- Benefits
  - Use of a volume-area relationship is a relatively simple approach
- Drawbacks
  - Does not account for evapotranspiration, groundwater recharge, and infiltration

Conservation Effects Assessment Project (CEAP) Floodwater Storage

- Volume-area relationship to estimate floodwater storage capacity
  - USGS study to quantify the ecosystem service benefits resulting from wetland restoration activities
- Collected topographic surveys to determine the surface area and volume of wetlands
  - Developed linear regression equation
- Using a wetland inventory water storage capacity was estimated for all restored wetlands on program lands
- Benefits
  - Relatively simple to apply
- Drawbacks
  - Does not account for dynamic hydrologic processes
    - Evapotranspiration, groundwater recharge, and infiltration

Flood Control, Water Supply and Storage

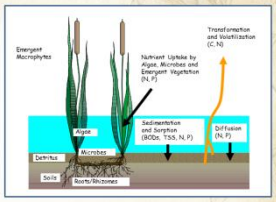
- Additional tools/models reviewed:
  - Soil and Water Assessment Tool (SWAT)
    - Widely applied
    - Water quality and quantity
    - Lumps all wetlands within a subbasin
  - Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST)
    - Broad landscape-based tool
    - Detailed wetland hydrological processes not reflected
  - Artificial Intelligence for Ecosystem Services (ARIES)
    - Broad landscape-based tool
    - Detailed wetland hydrological processes not reflected
  - HydroGeoSphere
    - Substantial scientific uptake
    - Less user friendly
    - Requires licence purchase

Water Purification

Tool / Model	Flood control	Water purification	Water supply	Climate regulation	Recreation and tourism	Science and education	Aesthetic	Biodiversity
CRHM	■	■	■					
SWAT	■	■	■					
IMWEBs	■	■	■					
2011 GoA	■	■	■	■				
ABMI		■						■
Industrial Heartland	■	■						■
CEAP	■	■	■	■				
InVEST		■	■	■	■		■	
ARIES	■	■	■	■	■		■	
SolVES					■		■	
MN Wetland Tool		■						■
HydroGeoSphere	■	■	■					
DNDC		■		■				

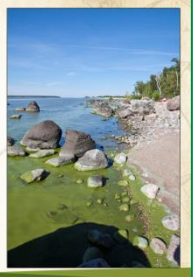
Water Purification

- Various approaches to modelling water purification
  - Both qualitative and quantitative
  - Limited options for an appropriate, quantitative model of nutrient sequestration at this time
- Ten models reviewed
  - CRHM, SWAT, IMWEBs, GoA Pilot, ABMI, Industrial Heartland, CEAP, InVEST, ARIES, MN Wetland Tool
- Most promising
  - **IMWEBs**
    - Couples water quality with hydrology
    - More than area based
    - Currently in development



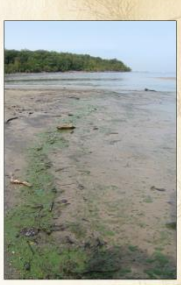
Water Purification

- Additional tools/models reviewed:
  - CRHM
    - Currently a water quality component in development
    - Initially applied at a field scale
    - Once developed, will consider nutrient (e.g., nitrogen and phosphorous) transport in both snowmelt and summer runoff periods
  - GoA Pilot
    - Water purification score
    - Uses six metrics to assess the ability of wetlands to remove nitrogen, phosphorous, and sediments from the water supply
    - Qualitative score
  - ABMI
    - Identify areas that contribute to non-point source export of nutrients, areas that remove nutrients and sediment, as well as impacts to water users
    - However, there are no wetland-specific parameters, including no nutrient removal rates



Water Purification

- Additional tools/models reviewed:
  - SWAT
    - Components of SWAT have been improved upon in IMWEBs
  - InVEST
    - Intended to be used as scenario comparison for different land use options
    - Nutrient retention by wetlands is largely a product of wetland area
  - ARIES
    - Broad ecosystem service tool (not specific to wetlands)
    - Nutrient retention by wetlands is largely a product of wetland area

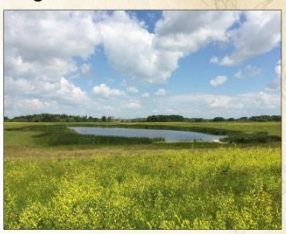


Climate Regulation

Tool / Model	Flood control	Water purification	Water supply	Climate regulation	Recreation and tourism	Science and education	Aesthetic	Biodiversity
CRHM	■	■	■					
SWAT	■	■	■					
IMWEBs	■	■	■					
2011 GoA	■	■	■	■				
ABMI		■						■
Industrial Heartland	■	■						■
CEAP	■	■	■	■				
InVEST		■	■	■	■		■	
ARIES	■	■	■	■	■		■	
SolVES					■		■	
MN Wetland Tool		■						■
HydroGeoSphere	■	■	■					
DNDC				■				

Climate Regulation

- Carbon sequestration is a function of more than just wetland area; however, that knowledge hasn't been converted into a usable model
- Five models reviewed
  - GoA Pilot, CEAP, InVEST, ARIES, DNDC
- Most promising
  - GoA Pilot



2011 GoA Wetland ES Pilot – Carbon Storage

- Carbon storage was estimated by applying estimates of soil organic carbon concentrations to the wetland inventory
- Applied to Class III, Class IV, and Class V wetlands
- Relatively simple approach that can be applied if a wetland inventory is available

Climate Regulation

- Additional tools/models reviewed:
  - CEAP
    - Similar approach to GoA Pilot
    - Used field data on soil organic carbon to estimate storage across program lands
    - Carbon estimates were from US PPR
  - InVEST
    - Land cover maps and stocks of carbon in aboveground biomass, belowground biomass, soil, and dead organic matter to estimate carbon stored in a landscape
    - Broad ecosystem service tool, rather than a wetland-specific one
  - ARIES
    - Estimates regional carbon balance through modelling carbon sources and potentially carbon sinks probabilistically
    - Broad ecosystem service tool, rather than a wetland-specific one
  - DeNitrification-DeComposition (DNDC)
    - Used to describe carbon and nitrogen biogeochemistry processes
    - Detailed, data-intensive
    - Has not had widespread use on prairie wetlands

Cultural Services

Tool / Model	Flood control	Water purification	Water supply	Climate regulation	Recreation and tourism	Science and education	Aesthetic	Biodiversity
CRHM								
SWAT								
IMWEBs								
2011 GoA								
ABMI								
Industrial Heartland								
CEAP								
InVEST								
ARIES								
SolVES								
MN Wetland Tool								
HydroGeoSphere								
DNDC								

Cultural Services

- Recreation and Tourism
- Science and Education
- Aesthetic
- Limited options for all three ecosystem services
  - Social Values for Ecosystem Services (SolVES)
    - Potential to be modified to reflect all three cultural services
    - Survey-based
  - InVEST and ARIES
    - Recreation and Aesthetic
    - Non-survey based

Cultural Services

- **Social Values for Ecosystem Services (SolVES)**
  - GIS-based tool used to quantify and map social values of ecosystem services
  - Uses responses to public value and preference surveys, along with environmental data, derive a relative social value index that is mapped across the study area
  - Ability to measure any of the cultural ecosystem services
    - Can be modelled along with environmental data (such as distance to water or dominant land cover)
    - Options for weighing the survey data as well as the spatial scale of the analysis
  - Benefits
    - Can be tailored to reflect ecosystem services of interest
  - Drawbacks
    - Primary surveys specific to wetlands that fit the requirements of the model inputs would need to be conducted to fully realize the potential of SolVES
      - Number of considerations to be taken for survey based approach

Cultural Services - InVEST

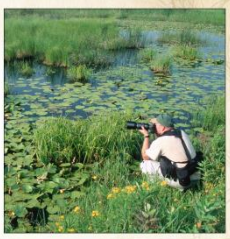
- **Recreation**
  - Uses location of recreation activities, and accessibility to predict the spread of person-days of recreation
  - Data requirements:
    - Locations of recreation activities and supporting infrastructure; distance between access points and activities; visitation rates
    - Geotagged Flickr photos as proxy for visitation
  - Output:
    - Map showing the spatial distribution of recreation use
- **Aesthetic**
  - Assesses the scenic quality of a landscape based on the location of natural desired features and development or infrastructure that impacts visual quality
  - Data requirements:
    - DEM; access points; location of public parks; location of private property; location of obstructions
    - Determines where features can be observed by viewers, locations of desired natural features and undesired infrastructure
  - Output:
    - Viewshed maps, determining visual impact

Cultural Services - ARIES

- **Considers the sources, sinks, flows and users to assess an ecosystem's ability to support cultural services**
- **Recreation**
  - Source: areas in the landscape that are suitable for a given a recreational activity
  - Sinks: areas that reduce recreational value, including undesirable visual features that reduce the quality of views
  - Flow: modelled using a road network with speeds and travel capacity as well as maps of recreational trails
  - Users: modelled based on population data, available data indicating a population's recreational participation (i.e., number of hunting or fishing licenses relative to population)
  - Output: relative recreational enjoyment unit
- **Aesthetic**
  - Source: user-defined source of aesthetic beauty such as mountains or water bodies
  - Sink: features contributing to visual blight
  - Flow: a line-of-sight model based on a DEM to identify locations where topography blocks views
  - Users: the presence of housing units
  - Output: relative scenic beauty value

Cultural Services

- Tool/model selection will depend on preferred approach and question to be answered
  - Could utilize a survey-based or non-survey approach
- SolVES
  - Survey would have to be conducted that fits model requirements
- InVEST & ARIES
  - Limited by data availability (i.e. recreation use rates)



Biodiversity

Tool / Model	Flood control	Water purification	Water supply	Climate regulation	Recreation and tourism	Science and education	Aesthetic	Biodiversity
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SWAT								
IMWEBs								
2011 GoA								
ABMI								
Industrial Heartland								
CEAP								
InVEST								
ARIES								
SolVES								
MN Wetland Tool								
HydroGeoSphere								
DNDC								

Biodiversity

- Five models reviewed
  - ABMI, Industrial Heartland, CEAP, InVEST, MN Wetland Tool
- Most promising:
  - ABMI Biodiversity
    - Uses species intactness index
    - Compares the predicted species abundance under current conditions with the predicted species abundance under the reference condition (no human footprint)
    - Based on data collected through ABMI's long-term biodiversity monitoring program
    - Estimate the relative abundance of a species in different human footprint types and ecosystem types while taking into consideration variation across the province due to climate, geographic location, and surrounding human footprint
    - Benefits:
      - Extensive data source for biodiversity in Alberta

Biodiversity

- Additional tools/models reviewed:
  - CEAP
    - Assesses plant community quality and richness on program lands
    - Assesses potential habitat suitability of ten bird species
  - Industrial Heartland
    - Assigns a qualitative score of biodiversity based on nine metrics
    - Values wetland size as opposed to valuing a diversity of wetland sizes
  - InVEST
    - Models habitat quality and rarity as a proxy for biodiversity using biodiversity threat locations, sensitivity of the land cover to threats
    - Gives only a coarse view of biodiversity
  - MN Wetland Tool
    - Habitat index based on sites of biodiversity significance, species of greatest conservation need, potential bird habitat, level of protection, and the type of habitat
    - Incorporates game species and is more of a biodiversity-recreation hybrid

Promising Models

Tool/model	Analysis scale	Analysis type	Data input	Supporting documentation	Skill level	Previously applied in AB	Freely available	Wetland specific	Flood control	Water purification	Water supply	Climate regulation	Recreation and tourism	Science and education	Aesthetic	Biodiversity
CRHM	Local	Quantitative	High	High	High	Yes	Yes	Adaptable	*		*					
SWAT	Local	Quantitative	High	High	High	Yes	Yes	Adaptable								
INVESts	Local	Quantitative	High	In Development	Moderate to High	No	Yes	Adaptable	*	*	*					
2011 GoA	Local	Quantitative, Qualitative	High	High	High	Yes	Yes	Yes	*		*	*				
ABMI	Regional	Quantitative, Qualitative	Moderate	High	Moderate to High	Yes	Yes	Adaptable								*
Industrial Heartland	Local	Qualitative	High	High	High	Yes	Yes	Yes	*							
CEAP	Local	Quantitative	Moderate	High	Moderate to High	No	Yes	Adaptable	*							
InVEST	Local to Regional	Quantitative, Qualitative	Low to High	High	Moderate to High	No	Yes	Adaptable								
ARIES	Local to Regional	Quantitative, Qualitative	Low to High	Moderate	Moderate to High	No	Yes	Adaptable								
SolVES	Local to Regional	Qualitative	Low to High	High	Moderate to High	No	Yes	Adaptable								
MN Wetland Tool	Regional	Qualitative	Moderate	High	Moderate to High	No	Yes	Yes								
HydroGeosphere	Local to Regional	Quantitative	High	High	High	No	No	Adaptable								
DNDC	Local to Regional	Quantitative	High	High	High	No	Yes	Adaptable								

Data Requirements

1. **Wetland inventory**
   - Consider the type of wetland inventory (i.e., Canadian Wetland Classification System (CWI; Adams et al. 1997), Alberta Wetland Classification System (AWCS; AESRD 2015), Stewart and Kantrud (1971)).

Data Requirements

1. **Wetland inventory**
2. **Land use map**

Data Requirements

1. **Wetland inventory**
2. **Land use map**
3. **Topography/elevation/LiDAR/DEM**

Data Requirements

1. **Wetland inventory**
2. **Land use map**
3. **Topography/elevation/LiDAR/DEM**
4. **Watershed/subwatershed boundaries**

Data Requirements

1. **Wetland inventory**
2. **Land use map**
3. **Topography/elevation/LiDAR/DEM**
4. **Watershed/subwatershed boundaries**
5. **Soils data**

Data Requirements

1. **Wetland inventory**
2. **Land use map**
3. **Topography/elevation/LiDAR/DEM**
4. **Watershed/subwatershed boundaries**
5. **Soils data**
6. **Climate data**

Data Requirements

1. **Wetland inventory**
2. **Land use map**
3. **Topography/elevation/LiDAR/DEM**
4. **Watershed/subwatershed boundaries**
5. **Soils data**
6. **Climate data**
7. **Population data**

Data Requirements

1. **Wetland inventory**
2. **Land use map**
3. **Topography/elevation/LiDAR/DEM**
4. **Watershed/subwatershed boundaries**
5. **Soils data**
6. **Climate data**
7. **Population data**
8. **Infrastructure data**
   - Including road networks, drainage infrastructure, and infrastructure in support of recreational activities (e.g., campgrounds, trails)

Guiding Principles for Wetland Ecosystem Service Valuation

1. **Prioritize the key wetland ecosystem services for valuation**
   - Direct effort to quantifying those ecosystem services that are most important to Alberta stakeholders. For the priority wetland ecosystem services, identify the questions to be answered and the level of detail required.

Guiding Principles for Wetland Ecosystem Service Valuation

1. Prioritize the key wetland ecosystem services for valuation
   - Direct effort to quantifying those ecosystem services that are most important to Alberta stakeholders. For the priority wetland ecosystem services, identify the questions to be answered and the level of detail required.
2. **No one tool should be considered for wetland ecosystem service valuation**
   - A single tool that can quantitatively model many services may do so suboptimally. Instead, select models that provide the best representation of the ecosystem services.

Guiding Principles for Wetland Ecosystem Service Valuation

3. **Favour models specific to wetlands**
   - General landscape planning tools may require unnecessary time compiling information unrelated to wetlands. Where possible, select a model meant for wetland types specific to Alberta.

Guiding Principles for Wetland Ecosystem Service Valuation

3. Favour models specific to wetlands
   - General landscape planning tools may require unnecessary time compiling information unrelated to wetlands. Where possible, select a model meant for wetland types specific to Alberta.
4. **Identify the resolution required and the data available**
   - More nuanced models will base ecosystem services on more than just wetland area; however, with some wetland ecosystem services, area-based models may be the only method of evaluation. Alternatively, simple models may produce the required output with fewer data requirements.

Guiding Principles for Wetland Ecosystem Service Valuation

5. **Consider the tool user**
   - If models are too data intensive or the model too difficult to run, then it is unlikely the tool will be widely adopted.

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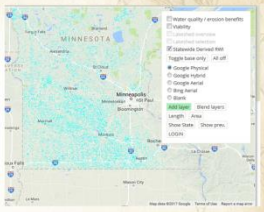
6. Consider the valuation output
   - Qualitative scores, in comparison to quantitative values, offer the opportunity to simplify assessments but shouldn't be solely relied upon.
7. **Weigh biophysical versus economic valuation**
   - Economic quantifications are most meaningful if they are based on high quality biophysical data. Ideally, a model should not be prioritized only because it directly incorporates economics. Strong biophysical data sets provide a longer shelf life than do economic valuations.

Jurisdictional Review

- Intentions
  - Learn more about wetland ecosystem services assessment approaches
  - How methods link to policy, programs and/or regional planning outcomes
  - Identify limitations to application and learning opportunities
- Four jurisdictions were investigated
  - Minnesota
  - Credit Valley Conservation (Southern Ontario)
  - North Dakota (USGS - Northern Prairie Wildlife Research Center)
  - Delaware

Minnesota

- Minnesota Restorable Wetland Prioritization Tool
  - Identify strategic locations for wetland restoration that maximize water quality benefits or habitat improvement
  - Intention: develop an online system that local governments could use to target areas for restoration
  - Made up of four main layers
    - Restorable Wetland Inventory
    - Three decision layers
      - Stress, viability, benefit

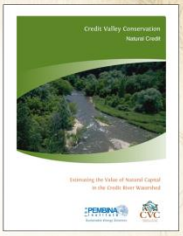


Minnesota

- Challenges/shortcomings
  - No measure of how the tool has been used for restoration
    - Monitor webpage visits as an indicator of its usage
    - Tool developers are interested in developing a tracker to build in additional data collection
  - Data availability
  - Assigning weights to variables within the models
  - Model support and development

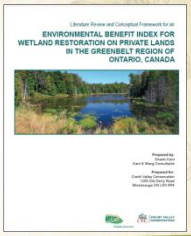
Credit Valley Conservation

- Conducted an assessment of natural capital and ecosystem services in the Credit River Watershed to understand the value provided by natural land cover types
- Used a benefit transfer method, to apply monetary values to the land cover types in the Credit River Watershed.
- Wetlands were found to provide the highest total and per capita value of all land cover types



Credit Valley Conservation

- Challenges/shortcomings
  - CVC recognized that the methods employed for the valuation study sacrifice precision in order to achieve a cost effective initial assessment
- Highlights the attention that ecosystem services should receive when making land-use decisions
- Results used to inform subsequent studies specific to wetlands, development of programs to support wetland restoration
  - Willingness-to-pay
  - Landowner preference surveys
- Resulted in the development of a wetland environmental benefit index (EBI)

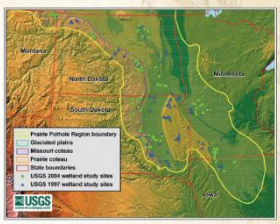


North Dakota - USGS

- Conservation Effects Assessment Project (CEAP)
  - Develop and apply methods to quantify changes in the ecosystem services provided by wetlands resulting from wetland conservation initiatives
  - Collected comprehensive field data on wetlands
  - Used field data to estimate the changes in ecosystem services provided by all wetlands on program lands
- Integrated Landscape Modeling (ILM) partnership
  - Broadscale regional trends (using InVEST)
    - Amphibian habitat, carbon storage, plant communities, pollination services, and bird habitat
  - Field level processed based modelling
    - Agricultural Policy/Environmental Extender (APEX)
      - Water quantity and quality

North Dakota - USGS

- Analysis at multiple scales allows for broad wetland ecosystem service assessment
  - Although currently no water quality and quantity assessment at scale above field-level
- Challenges/shortcomings
  - Not currently used for land planning
  - No tie to policy



Delaware

- Conducted a statewide evaluation of wetland ecosystem services
  - Intention: value changes in ecosystem services resulting from continued trends of wetland decline in Delaware.
- Used InVEST to estimate changes associated with:
  - Carbon storage
  - Water purification
  - Flood control
  - Wildlife protection
- Estimated both the biophysical change and the associated economic values

Delaware

- Challenges/Shortcomings:
  - Data inputs for the InVEST models:
    - Determining appropriate values for parameters in InVEST models
  - Results have not been used for any planning or policy influence
    - Without a wetland policy it was difficult to use the results to influence conservation or restoration

Jurisdictional Review - Summary

1. **Pair ecosystem service valuation with strong policy**
   - Each jurisdiction contacted recognized that where tools had either low application or poor tracking of application, there was no link to wetland policy.

Jurisdictional Review - Summary

1. Pair ecosystem service valuation with strong policy
   - Each jurisdiction contacted recognized that where tools had either low application or poor tracking of application, there was no link or a poor link to wetland policy. A strong wetland policy is the key to success.
2. **Proceed with both internal and external reviews**
   - Experience in Minnesota from internal stakeholder consultation found that, when confidence was possibly lacking in assigning a weight to various model components, moderate weighting was selected. As a result, external expert opinion was sought to more accurately reflect the mechanisms they were trying to capture.

Jurisdictional Review - Summary

3. **Track usage**
   - Identifying usage can help determine if implementation has been successful, or if modifications are required.

Jurisdictional Review - Summary

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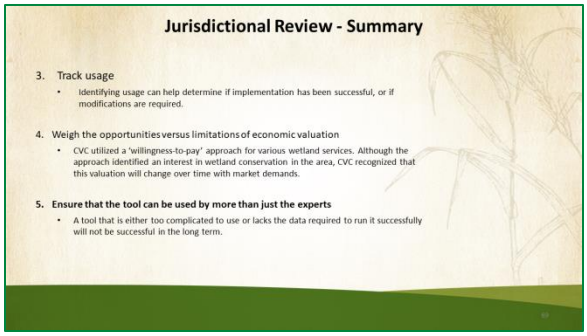
4. **Weigh the opportunities versus limitations of economic valuation**
   - CVC utilized a 'willingness-to-pay' approach for various wetland services. Although the approach identified an interest in wetland conservation in the area, CVC recognized that this valuation will change over time with market demands.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5. Ensure that the tool can be used by more than just the experts
• A tool that is either too complicated to use or lacks the data required to run it successfully will not be successful in the long term.


Discussion
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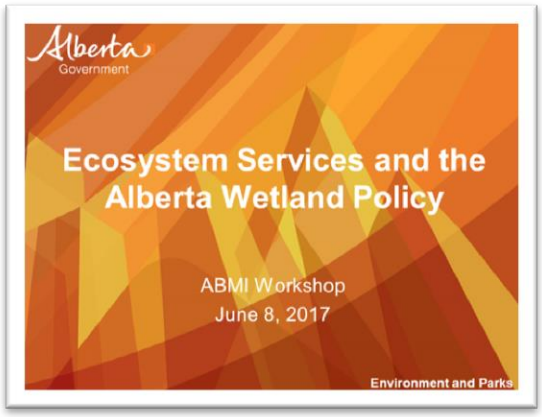
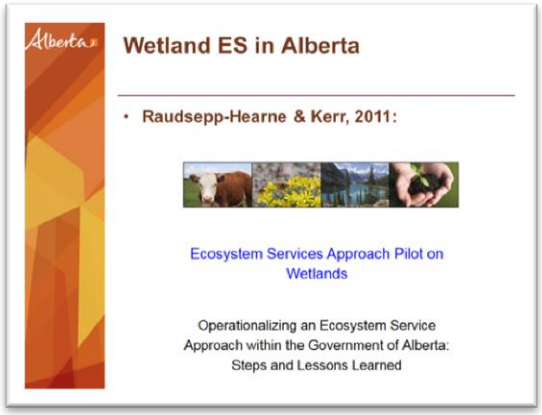
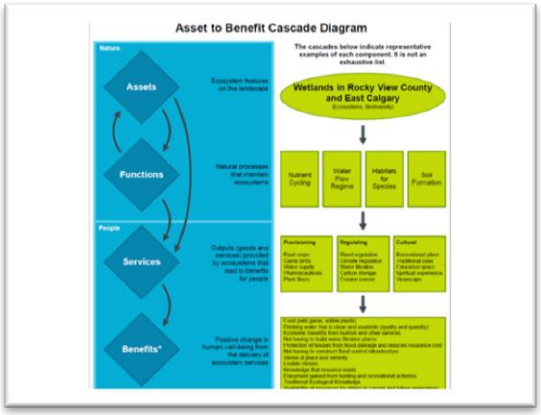
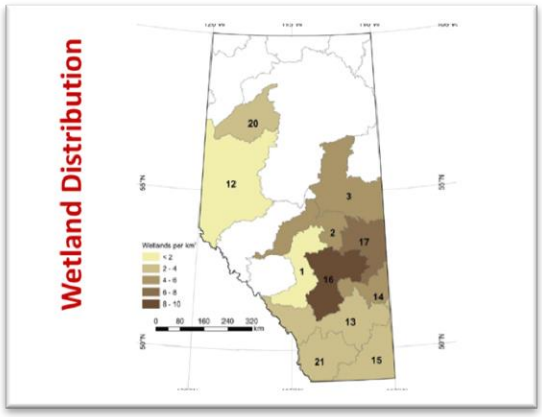
Appendix E: Ecosystem Services and the Alberta Wetland Policy

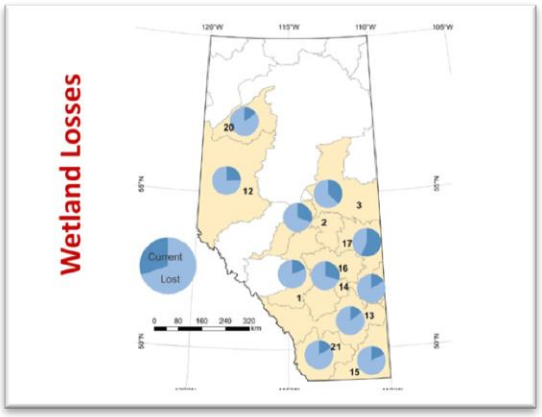
Presented by Thorsten Hebben, Alberta Environment and Parks





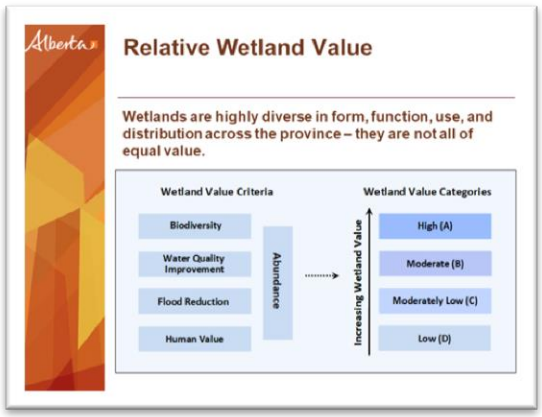


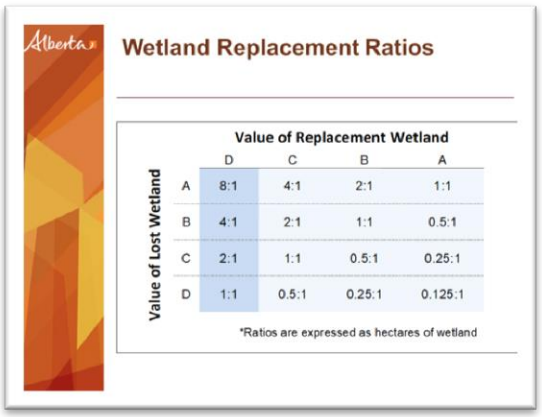

Wetland Distribution
Wetlands per km²
< 2
2 - 4
4 - 6
6 - 8
8 - 10
0 80 160 240 320 km
20
12
3
2
17
1
16
14
13
21
15


Wetland Losses
120°W
115°W
110°W
105°W
Current
Lost
0 80 160 240 320 km
20
12
3
2
17
16
14
1
13
21
15


Alberta
Policy Overview
Policy Goal:
– To conserve, restore, protect, and manage Alberta's wetlands to sustain the benefits they provide to the environment, society, and the economy
Policy Outcomes:
1. Wetlands of the highest value are protected for the long-term benefit of all Albertans
2. Wetlands and their benefits are conserved and restored in areas where losses have been high
3. Wetlands are managed by avoiding and minimizing negative impacts, and, where necessary, replacing lost wetland value
4. Wetland management considers regional context


Alberta
Wetland Mitigation Hierarchy
Avoid
Minimize
Replace
Avoidance
The preferred response is to avoid impacts on wetlands.
Minimization
Where avoidance is not possible, proponents will be expected to minimize impacts on wetlands.
Replacement
As a last resort, and where avoidance and minimization efforts are not feasible or prove ineffective, wetland replacement will be required.


Alberta
Relative Wetland Value
Wetlands are highly diverse in form, function, use, and distribution across the province – they are not all of equal value.
Wetland Value Criteria
Biodiversity
Water Quality Improvement
Flood Reduction
Human Value
Abundance
Increasing Wetland Value
Wetland Value Categories
High (A)
Moderate (B)
Moderately Low (C)
Low (D)


Alberta
Wetland Replacement Ratios
Value of Replacement Wetland
Value of Lost Wetland
D C B A
A 8:1 4:1 2:1 1:1
B 4:1 2:1 1:1 0.5:1
C 2:1 1:1 0.5:1 0.25:1
D 1:1 0.5:1 0.25:1 0.125:1
*Ratios are expressed as hectares of wetland

Key Learnings to Date

- Ongoing cultural hurdles:
  - Public perception of wetlands as wasteland and hindrance to development and progress
  - Continued promotion of straight-line tillage, ditching, and tile drainage
  - Incomplete understanding of regulatory accountabilities under the provincial *Water Act*
- Importance of translating function to benefit:
  - Landowners unable to evaluate wetland functions/values in meaningful economic terms.
    - Need to support informed decision-making
    - Tradeoffs not clearly understood
- Long-term direction may capture ES.

Land-Use Planning

- Key area for wetland conservation and protection:
  - Regional/sub-regional plans
  - Municipal Plans and conservation/restoration initiatives
  - Provincial conservation areas (part of 17%)
- Enabled through powerful legislation:
  - Alberta Land Stewardship Act
  - Municipal Government Act
  - Environmental Protection and Enhancement Act
  - Provincial Parks Act
  - Wilderness Areas, Ecological Reserves, Natural Areas and Heritage Rangelands Act
- Opportunities to explore benefit conversation at higher resolution and more localized scale.
  - Greater potential for stakeholder engagement.