Ecosystem Services Approach Pilot on Wetlands

Operationalizing an Ecosystem Service Approach within the Government of Alberta: Steps and Lessons Learned

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Ecosystem Services Pilot Acknowledgements of Contributors

There were over 40 people that formed the Ecosystem Services Approach Pilot on Wetlands. Some left the pilot before it was completed and some joined mid-stream. It is important to recognize the people that committed in various ways to the successful completion of this work:

Angele Vickers, Anish Neupane, Arnold Janz, Barry White, Blake Mills, Brian Hills, Brett Johnson, Carolyn Tralnberg, Charles Iceland, Dr. Chokri Dridi, Christian Schleyer, Chris Spytz, Dr. Ciara Raudsepp-Hearne, Courtney Hughes, Dan Farr, Eric Beveridge, Erika Almási-Klausz, Fiona Slessor, Florence Landsberg, Geneva Claesson, Gillian Kerr, Dr. Glenn Brown, Heidi Wittmer, Joanna Johnson, Johannes Förster, Jonathon Thompson, Justin Wilkes, Karen Hughes-Field, Karen Raven, Kerri Charest, Kim Shade, Krista Tremblett, Lana Robinson Dr. Lee Foote, Luis Leigh, Dr. Marian Weber, Meghan Snowdon, Mona Keffer, Morris Seiferling, Rob Dunn, Rob Simieritsch, Rifaat Hammad, Rebecca Reeves, Scott Millar, Shane Gabor, Shari Clare, Tom Klavins, Dr. Tomas Nilsson Tracy Scott, Valerie Sexton, Dr. Vic Adamowicz, Wanjing Hu, Yihong Wang

About the Report

The Ecosystem Services (ES) program within Alberta Environment and Sustainable Resource Development (ESRD) has been advancing the use of an 'Ecosystem Services Approach' within the Department and the Government of Alberta since 2007. The Ecosystem Services Approach Pilot on Wetlands (the 'ES Pilot') is part of the Department's 10-year ES Roadmap; the pilot's completion and results are considered a progression in understanding and applying an ES Approach to support decision making.

Important to note for the reader, the combined complexity of ecosystems and interactions with people, including the functions, services and benefits they provide, is a challenging new arena for science. The work of this pilot team and the results presented are a step forward in building an understanding and knowledge of ES and using an ES Approach; however we caution the reader that there is more work to be done, both in Alberta and globally to strengthen the meaning and use of ES Approach results. Therefore, the information provided in this report on the ES Approach, which includes steps taken and lessons learned, is critically important to understand some of the things that went 'right' and other areas where things could be done better and why. In some cases, challenges experienced were a result of a lack of capacity and, in other cases it was lack of experience or time availability. The ES Pilot was truly an iterative, "learn as you go process" in which activities and processes were modified due to the changing circumstances and expectations.

The purpose of this report is to provide those interested in using an ES Approach and other interested readers with an understanding of the approach taken and limitations identified in the approach itself, as well as the results. Based upon advice and experience of international experts it is understood that the work to assess ES within a strong policy context, and using knowledge from multiple disciplines, is leading edge, and attempts were made to ensure the pilot and results presented are credible, legitimate and policy relevant. Globally, there are no international standards, methods or processes for conducting an ES assessment in the context of a land use policy issue.

The report is laid out in five sections and includes an Executive Summary. The Executive Summary provides a high-level overview of the pilot context, a summary of the assessment results, links to pilot objectives and key conclusions and recommended next steps for an ES Approach in Alberta. Section 1 explains the specific context of the ES Pilot, its goals and limitations. Section 2 outlines the methods used by the ES Pilot to complete the 6 steps of the 'ES Approach'. Section 3 describes how the project was organized and discusses organizational challenges related to project structure, leadership, communication and cross-disciplinary collaboration. Section 4 discusses how an ES Approach could be operationalized in different contexts within ESRD to meet different objectives. Section 5 provides summary conclusions as well as potential recommendations and next steps to be considered for ESRD ES program and ES Roadmap. There are a number of complementary deliverables prepared for the ES Pilot. Other reports include: an Integrated Results Report that focuses on the methods and results and how they meet the objectives of the ES Pilot, a Project Evaluation Report, a Summary Report for Decision makers and a Summary Report for a general audience. In addition, there are a number of technical reports including: reports for various components of the biophysical assessment, a socio-economic report and the socio-cultural report. As such, a detailed overview of the methods used is not included in this report.

The combined deliverables for the ES Pilot together provide all the key elements for understanding the results, the methods, project evaluation and the learning's from the Ecosystem Services Approach Pilot on Wetlands that can support future work on ES in Alberta and internationally.

Executive Summary

Ecosystem services (ES) is a concept designed to allow us to acknowledge the different ways in which the environment supports human economies, the everyday lives of individuals, health and well-being, and sustainable communities. This concept can be used to communicate the importance of the environment in terms that people have not considered previously, and can be used to focus research on how best to manage the environment to sustain human well-being.

Greater expertise in ecosystem service science would allow Alberta Environment and Sustainable Resource Development (ESRD) to go beyond following high-level steps for ecosystem service assessment to developing context-specific and refined approaches to suit a multitude of information needs. Ecosystem service research is complex because it attempts to understand complex interactions between human societies, their economies and value systems, and the environment, at multiple scales and over time. Greater comfort with the flexibility of the ES concept and all the approaches currently used to understand ES would help in the identification of the parts of a system that need to be assessed in order to answer specific questions. This in turn would suggest what kind of approach could be used to complete an ES assessment as efficiently as possible.

There are a number of key lessons from the ES Approach process and review.

- Develop the approach to the unique context. There is no one ES Approach. Projects need to tailor the approach to the local circumstances, objectives and competencies of project members;
- Develop an agreed upon conceptual framework to guide the overall ES Approach work.
- Ensure that the problem or issue is constantly recalled and discussed in the context of current activities to manage expectations and scope creep;
- Choosing the ES that will be the focus of assessment is a critical first step and should be completed before other work is started;
- Select the ES based on best available information at the time and move on. Choosing the focus ES needs to be completed quickly. Comprehensiveness must be balanced with the real limitations of available resources;
- Have the right skills and competencies involved. The assessment of each ES needs to be led by an individual or team with expertise in the specific science of that ES. Complementarily, individuals with an understanding of the relationship between ES is valuable to ensure cross-pollination of assessment methods;
- Important to ensure that there is a common understanding of risk and that the risks and opportunities are relevant to the decision-makers;
- It is critical to provide credible and relevant information through a legitimate process and to be transparent about limitations of processes and results;
- Decisiveness from project leaders (including the Steering Committee) is needed to promptly balance time allocated to discussions, theoretical issues, and stakeholder participation, with achieving progress and organizing the work within project timelines;
- There are no straightforward guidelines available on how to organize multi-disciplinary work on multiple ES; therefore careful planning on how work is distributed among individuals and teams is required in order to develop information that directly answers to the needs of decision-makers; and
- Strong support from project champions was critical to carry the pilot to completion, particularly when there were challenges.

There are a number of key recommendations from the ES Approach process and review as enumerated below:

- There is an opportunity to situate future ES approach and ES investigations/projects into key GoA policy initiatives and strategies that are underway or being updated (See Figure 1);

- Revise ES roadmap with learnings from ES pilot and include in ESRD-wide distribution and training; and

- Review and implement opportunities to use ES to inform decision-making.

1. Introduction to ES Approach Report

Ecosystem services is a concept designed to force us to acknowledge the different ways in which the environment supports human economies, the everyday lives of individuals, health and well-being, and sustainable communities. This concept can be used to communicate the importance of the environment in terms that people haven't considered previously, and can be used to focus research and policy on how best to manage the environment to sustain human well-being.

This report was one of the key deliverables required by the ES Pilot to provide a concise overview of how the ES Approach steps were undertaken and the experience and advice of the ES team about the ES Pilot outcome: the development and operationalization of an ES Approach to provide a tool to enhance decision making. It is therefore written for persons interested in understanding how the ES pilot team modified the generic ES Approach and a number of the challenges and successes with the Approach. It intended to be a useful document for others that want to consider building an ES Approach into their work. It also supports one of the objectives to try to operationalize the ES Approach for decision-making within ESRD. As such there are four primary components to the report.

This Report will:

1. Describe the specific context of the ES Pilot Project on Wetlands ('ES Pilot'), its goals and limitations;

2. Outline the methods used by the ES Approach Pilot on Wetlands to complete the 6 steps of the 'Ecosystem Services (ES) Approach';

3. Describe how the project was organized and discuss organizational challenges related to project structure, leadership, communication and working across disciplines; and

4. Discuss how an ES Approach could be operationalized in different contexts within ESRD to meet different objectives.

The report can be read from cover to cover or the reader can pull out sections of interest or use.

1.1 Relevance of ecosystem services to ESRD

Ecosystem services ('ES') are the benefits that nature provides to people. Ecosystem services are valuable to people in different ways: they provide material goods for life (e.g. timber, food, freshwater), they provide inputs into development objectives (e.g. purification of water, opportunities for recreation and tourism), and they support functioning landscapes that provide multiple ES (e.g. nutrient cycling, climate regulation). Strategic management of ES requires a good basis of understanding related to how ES are produced, consumed and valued within a given context. This report focuses on the development of an approach to ES assessment in Alberta as part of the goal of informing cumulative effects management (CEMS) (see *Text box 1*).

Traditionally, land-use planning was often based on the value and the utility of only one, or a few ES, particularly those that can be marketed (e.g. timber, crops), and on what can be done with the land later on (e.g. after deforestation). There has rarely been any assessment of the wider ES being provided by ecosystems (e.g. climate regulation, erosion control, water purification, maintenance of genetic diversity, among others). The reality is that such services often have a high value, and because most ES interact with each other, the degradation of the ES that are often ignored in management can lead to losses in the ES that are directly valued and managed. For example, achieving maximum yields of crops can lead to erosion, loss of soil moisture and nutrients, and reduction in natural pest control, eventually leading to a degraded agricultural system. Ignoring ES can lead to decision-making based on incomplete information, and therefore less than optimal outcomes for people.

"Undertaking an ecosystem services assessment and taking the findings into account in policies and action can improve the long-term outcome of decisions" (Ash et al., p.5). Therefore, using an ES approach presents an opportunity to improve environmental management and decision-making. This approach makes explicit the "trade-offs" inherent in our decisions: between different ES (wood provision or climate regulation), between different beneficiaries (private gain by some, public loss to many), at different scales (local costs, global benefits), and across different time horizons.

One of the principal issues for ES management is that there is a marked tendency to not manage what we do not measure. Dedicated systems of measurement, monitoring, and reporting for ES are needed. The lack of measurement is leading to decisions that result in unknown changes to ecosystems. These changes can impact multiple ES, and have direct economic and social repercussions that impact the well-being of Albertans. Recognizing and understanding ES allows decision-makers to consider previously unseen 'benefits' from ecosystems, as well as mitigate unforeseen impacts of human activities. Identifying and understanding these "trade-offs" at the point of decision-making, and not as a consequence of past decisions, will enable decision-makers to proactively manage environmental risks and opportunities. In turn, this will ultimately improve cumulative effects management on the landscape.

An ES approach can support cumulative effects management by providing:

- A forum for recognizing social and economic values derived from the environment;
- A mechanism to link social and economic outcomes to environmental outcomes;
- A comprehensive approach that integrates all environmental media to support policy/decision-making and planning;
- An opportunity for the development of innovative, effective, and efficient environmental tools;
- A mechanism to deliver environmental outcomes by identifying the ES and the natural asset that contribute to achieving the outcome;
- An illustration of society's dependence on ES for human well-being (e.g. clean water, fresh air, and food); and
- Context before analyzing spatial information

Within ESRD, the ES Roadmap presents the vision and overarching goal of the ES program, which helped to frame and scope the ES Pilot:

ES Program Vision: To contribute to a comprehensive theory and practice for understanding ES and to ensure the ES approach is consistently incorporated into policy, planning, and decision-making within ESRD.

ES Program Goal: A strong quantitative and qualitative capacity exists within ESRD to enable the ES approach to be common practice within the department's policy, planning, and decision making processes.

Text box 1 – Cumulative Effects and Cumulative Effects Management (CEMS)

Within Alberta, Cumulative Effects Management System has become an environmental management priority through the *Alberta Land Stewardship Act* and the business plan priorities of ESRD and other departments.

Cumulative Effects is defined as "the combined effects of past, present and reasonably foreseeable land-use activities, over time, on the environment." (Land-use Framework, 2009). Sometimes this will occur over time, for example, when new development starts up in an area that already has environmental impacts from previous activities. Cumulative effects also occur when multiple activities take place across an area and lead to synergistic and sometimes rapid impacts on the environment. Wetland loss is a prime example of cumulative impact on ES as the issue is driven by the loss of many small basins which, cumulatively, equate to a large cumulative effect.

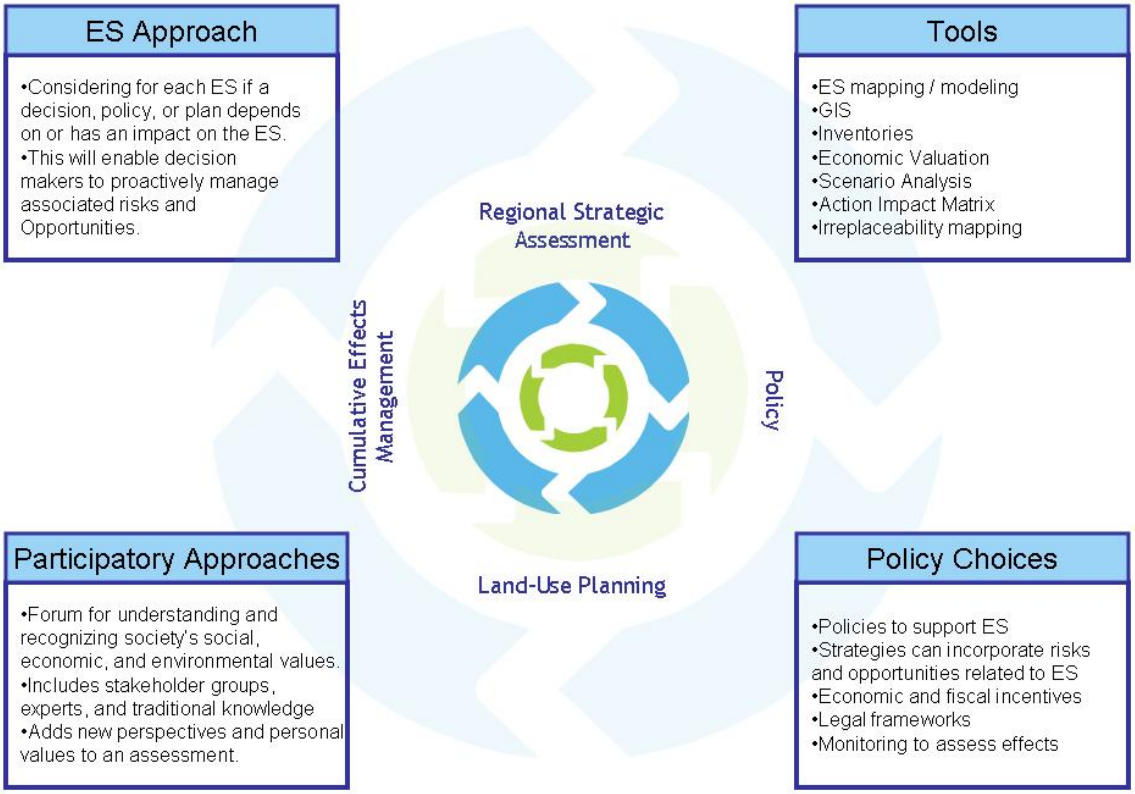
Cumulative effects *management* aims to set environmental objectives in consideration of their social, economic and environmental consequences and to manage activities, through a process of continuous improvement, in order to achieve those objectives. It is not an add-on to Alberta's current management system, but an evolution of that entire system.

The ES methodological approach can support cumulative effects management by providing:

- qualitative and quantitative methods to determine cultural and economic benefits derived from the environment in a place-based context;
- integrated information on the biophysical, economic and cultural dimensions of environmental resources to support trade-off discussions in decision making, policy and planning; and
- science and social-science-based evidence of society's benefits and dependence on ES for human well-being (e.g. clean water, fresh air, and food).

There are a variety of focus areas where an ES approach could be integrated into ESRD work. One major focus area is in 'policies and plans' to support the management of cumulative effects and sustain the well-being of Albertans. *Figure 1* outlines the ES approach and the various tools that can be used to integrate ES information into ESRD operations, policies and plans. These tools are flexible, multifaceted, and could support many departmental priorities. They can also be used in conjunction or separately, depending on the process being supported.

Figure 1. Ecosystem service approaches and tools to integrate ES information into ESRD operations



1.2 ES Pilot Context

Previous assessment work of ES in Alberta was completed to inform the South Saskatchewan Regional Plan (SSRP) during the outcomes setting part of the plan. The ES information was greeted with interest and enthusiasm by decision-makers, but feedback also included a request for more quantitative information about ES on the landscape and their value to individuals and communities. Decision-makers wanted information that was credible, defensible and relevant to the decisions they faced, and emphasized a need for economic values in addition to biophysical information about the distribution, quantity and quality of ES.

> **ESRD's ES Road Map** sets out the goals and path forward to support integration and adoption of the ES approach. Adopting an ES approach will support and enable ESRD's work on cumulative effects management, policy development, planning, and decision-making.
>
> *Short term goal (now-1 yr):* An enhanced appreciation and understanding of an ES approach to supporting policy, planning, and decision making is identified and supported by all levels of relevant management in ESRD.
>
> *Medium term goal (now-3yrs)*: The importance of ES is better understood and the department has increased its capacity for quantitative measurement of ES on the landscape to support policy, planning, and decision-making within ESRD.
>
> *Long term goal (3-7yrs):* A strong qualitative and quantitative capacity exists within the department to enable the ES approach to be common practice within ESRD's policy, planning, and decision-making processes.

The ES Approach Pilot on Wetlands ('ES Pilot') was initiated in 2010 with the goal of further developing an ES Approach and methods, and operationalizing the ES Approach on the ground for a real issue that current ESRD staff are dealing with. This pilot was set as a Ministry priority through the department's Director's Corporate Operational Planning process and was allocated the estimated budgeting and resource commitments necessary for completion. The ES Pilot became a principal component of the short-term goals of ESRD's *Road Map for Ecosystem Services in Alberta*[1]. The Road Map articulates a strategy for integrating ES into ESRD's governance, policy and programs (see text box).

The ES Pilot was conducted in an area encompassing the east part of the City of Calgary, the Municipal District of Rocky View and the Town of Chestermere, where residential sub-division development is having an impact on the ES that are supplied by wetlands and their surrounding landscapes. The ES Pilot focused on assessing the benefits that people get from wetlands in a quantifiable and comparable way.

The scope of the ES Pilot was determined in the Fall of 2010 through discussions with wetland experts, regional government staff and biological/ecological/economic experts from ESRD, other ministries and other institutions. The outcome for the pilot was established as the following: "the development and operationalization of an ES Approach to provide a tool to enhance decision making". The pilot charter originally had five objectives but these were modified as an understanding of the pilot needs and constraints progressed. In addition to the outcome noted above, the Steering Committee agreed to the following objectives:

- Test and demonstrate how an ES Approach can be used to support decision making by explicitly demonstrating the tradeoffs between development and ES benefits provided by wetlands; and

[1] For information on the ESRD Ecosystem Services Roadmap, please contact Gillian Kerr at Gillian.kerr@gov.ab.ca.

- Support wetland management in the province by providing additional information to support potential compensation decisions related to land-use development.

Additionally the ES Pilot team deemed it important to also identify information and capacity gaps for ES assessment to support future ES work, and as such, this third objective was also established.

Meeting these objectives involved developing biophysical, socio-cultural and economic information on wetland ES to answer specific questions from wetland approval decision-makers. The ES Pilot had 14 months to organize an assessment process and develop information to meet the needs of decision-makers, and a budget of approximately $500,000. Approximately 10 full time equivalents from the ES team were involved in the core work of the assessment, excluding consultants that were hired to do the actual assessment work. This number actually represents the partial time committed from the 44 people on the ES Team. Individuals on the ES Team contributed between 5 and 75 percent of their time, although only 2 people were at the high end of this range. Due to the pilot nature of this assessment, it was not expected that the assessment process and final products would be developed to a level that met the pilot criteria of being credible, legitimate and policy relevant. However, the ES Pilot was a necessary first step towards understanding how ES can be assessed, and how ES information could be incorporated into decisions within ESRD.

1.3 An Approach for Assessing Ecosystem Services

The ES Pilot was built on previous experience of the ESRD team working with the ES Approach on the Southern Alberta Landscapes (SAL) project and the South Saskatchewan Regional Plan (SSRP). In addition, there were a number of good insights on the approach from the three-years of Institute for Agriculture, Forestry and Environment (IAFE) work. The ES Pilot planning team spent time reviewing the work within the SAL, SSRP and IAFE to ensure that the lessons learned, including successes, failures and road blocks were understood. While this previous work had conducted steps equivalent to Steps 1-3 in the ES Approach used by the ES Pilot (see *Figure 2*), the pilot presented an opportunity to go further and link an assessment of ES to human well-being in a quantitative manner.

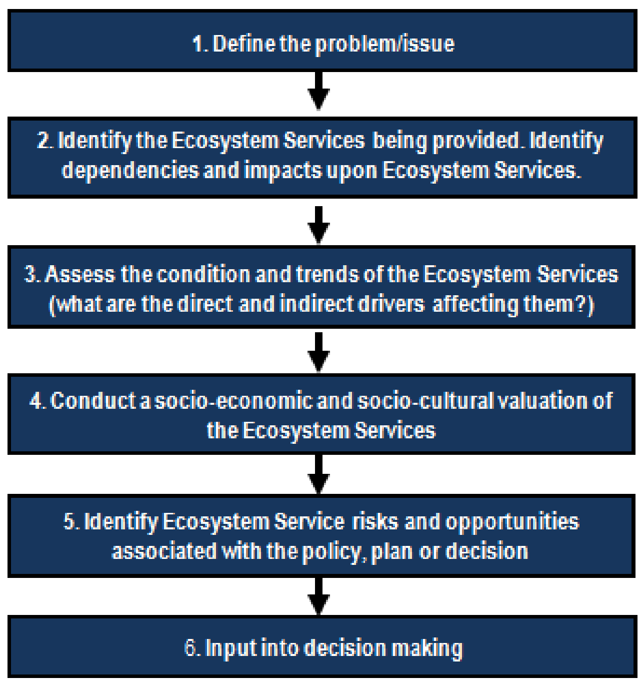


Figure 2: Ecosystem Services Approach, adapted from WRI, 2007.

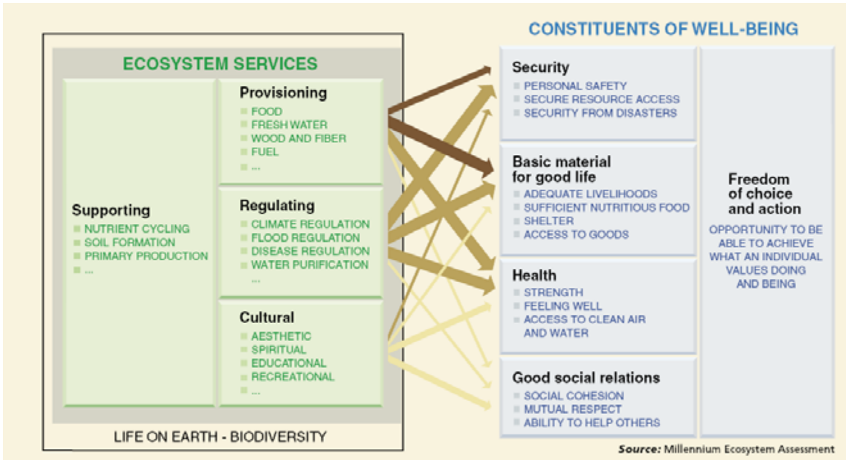
The ES Pilot followed process guidelines provided in two recent ES assessment manuals: Ecosystem Services and Human Well-Being: a manual for assessment practitioners (Ash *et al*., 2010) and Ecosystem Services: a guide for decision-makers (WRI, 2008).

The ES Pilot began the process with a seven step approach process that split apart step 2; however this was compressed into the six step process in early 2011 as the sub-teams realised it was more logical to keep these steps together. The two manuals both emphasize developing a process and products considered to be *scientifically credible, relevant to key decision-makers, and legitimate in the eyes of stakeholders*. The process suggested to promote these principles involves developing a community of scientists, reviewers, advisors and stakeholders to guide a multi-disciplinary assessment. The benefits to having such a process are obvious, however, organizing the process proved very challenging given the constraints of the ES Pilot. An example of the challenges faced while building these principles was the development of a conceptual framework for the pilot, an exercise suggested by the ES manuals to get everyone to a common understanding of ES within a particular context before embarking on assessment activities.

Based upon previous ESRD work, the conceptual framework that was initially adopted by the ES Pilot was a diagram produced by the Millennium Ecosystem Assessment that ties ES to constituents of Human Well-being (*Figure 3).* While it provided high-level guidance on how the team could connect ES information to relevant information for the pilot's decision-makers (i.e. the quality of life of Albertans dependent on functioning wetlands), the ES Pilot Team decided in the spring of 2011 that it was not specific enough to guide the detailed work of the ES pilot. There was also a recognition that activities needed to be conducted that allowed for improved integration across all the different sub-team work and common understanding. A number of exercises were undertaken to develop a more specific and custom-made conceptual framework, leading to the development of the Cascade Diagram (*Figure 4*). The Cascade Diagram became the conceptual framework for how wetlands lead to benefits that decision-makers can consider in their decision making, and helped to order the assessment work.

It should be noted that the Cascade Diagram (*Figure 4*) is not a complete conceptual framework that captures all the key components of the links between ES and human well-being. The Cascade Diagram is a static figure that explains how ES are produced and lead to human well-being, but does not incorporate the dynamic feedbacks from humans to the ecosystem. For example, it does not capture how drivers of change such as population growth and development impact ES. For the purposes of a short pilot, the Cascade Diagram was extremely useful for organizing the assessment work and integrating methods across different assessment sub-teams. However, future work that attempts to understand how humans both impact and benefit from ES might benefit from a more complete conceptual framework to guide this work. A conceptual framework is important for determining where management interventions could occur to sustain ES and human well-being.

Figure 3. The links between ecosystem services and human well-being



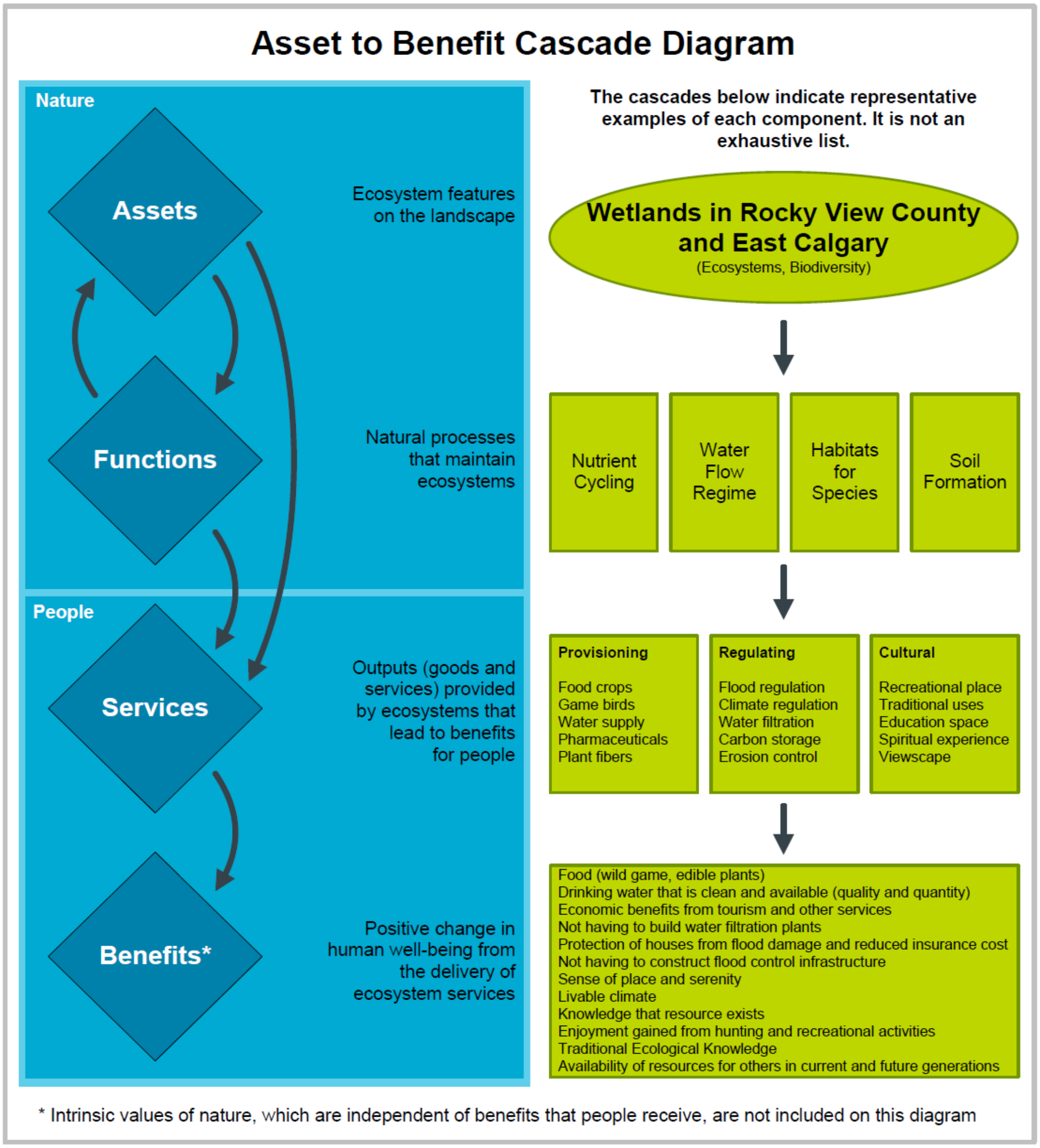
The organization of a full assessment process may not always be necessary to provide relevant and credible information about ES to decision-makers. This report describes the assessment process tested by the ES Pilot, reports on the challenges, benefits and shortcomings of the approach taken, suggests how lessons learned could be applied to improve future ES assessments, and provides ideas on how ES information can be developed and used in different contexts within ESRD.

The next sections of the report describe:

- The six steps of the ES approach that were undertaken (see **Figure 2**)
- How the assessment work was organized
- How ES assessment can be operationalized within ESRD

In each section we pull out the fundamental lessons learned that will inform future ES work in ESRD.

Figure 4. Cascade diagram used to illustrate links between natural assets, ecological functions, ecosystem services and benefits to humans



2. Steps in the ES Pilot Approach

Table 1 summarizes the important steps in the project methodology for completing the ES approach (WRI 2008). Each of these steps will be expanded upon in subsequent sections. The WRI handbook for assessment was clear in stating that the steps proposed were not sequential but rather an adaptable set of steps that could be completed iteratively and in a different order. The organizational steps presented in Section 3 are not included here, but are just as crucial to achieving desired outcomes, and building the credibility, legitimacy and relevance of the assessment work.

Table 1. Steps in the ES Pilot Approach

ES Approach Steps	Methodology Steps
1. Define the problem/issue	**a**. Identify a policy, project or process that an ES assessment could inform
	b. Choose a case study area for assessment, decide on boundaries
2. Identify priority ES to be assessed	**a.** Identify ES produced by wetlands in pilot study area and determine the ecological processes and natural assets important in their production
	b. Prioritize the ES that will be the focus of further assessment activities using criteria from decision-makers and criteria related to degree of dependencies and impacts of multiple stakeholders
3. Assess condition and trends of priority ES	**a.** For priority ES, choose indicators linked to either the production or consumption of the service that are relevant to decision-makers and other stakeholders
	b. Develop and implement methods for assessing the current condition of each service (assessed in relation to a baseline condition or to an ecological or societal threshold) and recent trends in the service (rate of change, positive or negative)
	c. Identify drivers of change acting on ES and assess trends in drivers
4. Evaluate economic and socio-cultural benefits to human well-being from ES	For priority ES, develop information on how stakeholders benefit from, and explicitly value ES from economic and socio-cultural perspectives.
5. Identify ES risks and opportunities for management	Integrate information on condition and trends in ES, impacts to benefits to human well-being (both economic and socio-cultural), and future projections of trends, and identify management risks and opportunities related to ES.
6. Input ES information into decision-making	Develop specialized reports, figures, tables and maps to communicate relevant findings to specific decision-makers and stakeholders.

2.1 Overall ES Approach Considerations

The six steps of the ES Approach piloted within ESRD were modeled off of the World Resources Institute (WRI) and guidance from the WRI was largely focused on their application of this approach on the Puget Sound. This section provides a high level overview of the steps taken and lessons learned. However before describing each step, there are a number of overall considerations that are critical to the success of an ES Approach.

Critical Lessons Learned

- Develop the approach to the unique context. There is no one ES Approach. Projects need to tailor the approach to the local circumstances, objectives and competencies of project members.
- Conduct project activities in a transparent and participatory manner to ensure credibility of process and outcomes. Uncertainty is a continuous part of ecology and ES assessments and must be dealt with in a transparent and consistent way.
- Develop an agreed upon conceptual framework to guide the overall ES Approach work.
- Develop a consistent and efficient method to fill information gaps or capture where gaps remain and the consequence of those gaps.
- Uncertainty is a continuous part of ecology and ecosystem services assessments and must be dealt with in a transparent and consistent way.

The ESRD ES team began the pilot talking about the use of an ES Approach that had been trialed and developed internally. It is important to note, especially in light of the objective and outcome to operationalize the ES Approach, that there is no single approach. The approach taken depends on the type of issue, the timeline and scale of the project, access to data and information and a number of other considerations that will be highlighted in Section 4. It is therefore critical that the ES team developed an ES Approach that is most applicable and relevant to the context and circumstances that they find themselves in.

A step toward making the ES Approach specific to the issue and context is to have the ES Team build a common conceptual framework to guide the process and ensure that the team is consistent with how the ES information is being connected to something of meaning for the decision-makers. In the beginning, the ES Pilot team assumed that the use of the WRI conceptual framework tying ES to the UN Constituents of Human Well-Being would be sufficient. As the team got deeper into its work, this proved to be inadequate and created a need to slow all other work down and bring the Core Team together to ensure there was a consistent understanding of the conceptual framework for the ES Pilot work. One of the exciting products that came out of the exercise was the Cascade Diagram (**Figure 4)** series that provided both a useful tool to frame the ES assessment work and as a communication tool to others.

"Ecosystem service science is poor" (Tallis et al. 2008). An ES assessment should adopt a consistent approach for assessing, characterizing, and reporting uncertainties about findings. Any important factors and uncertainties that could affect a conclusion should be identified throughout the assessment as this provides information on which a conclusion or estimate is based[2]. In

[2] MA (Millennium Ecosystem Assessment). 2005. *Living Beyond Our Means: Natural Assets and Human Well-Being: Statement from the Board.* Washington DC: WRI. Online at: http://www.maweb.org

building any ES Approach it is important to recognise there will be uncertainty. To ensure that the team builds collaboratively and recognised uncertainties and how they are being dealt with it is important to have a consistent and efficient method to capture and deal with gaps. Be clear from the start on the assumptions used, and limitations of the results.

Step 1: Define the Problem/Issue

Step 1 includes 2 sub-steps:

- **a.** Identify a policy, project or process that an ES assessment could inform
- **b.** Choose a case study area for assessment, decide on boundaries

Purpose of Step 1

This step involves identifying the focus of an ES assessment. Without a clear focus and objective, and ES assessment will not provide useful information with the potential for improving ES management for human well-being. Ideally, ES assessment information will be developed to meet the specific needs of decision-makers and will feed directly into a policy or decision-making process. The case study area is identified and its boundaries clearly delineated in accordance with the needs of decision-makers.

Critical Lessons Learned

- Be as specific as possible about the policies or projects that assessment information will feed into is key for developing relevant findings.
- Develop very detailed and specific questions for the assessment work to answer helps to organize the assessment work, providing a clear path forward.
- Ensure that Step 1 – the problem or issue – is constantly recalled and discussed in the context of current activities to manage expectations and scope creep.

A. Identify a policy, project or process that an ES assessment could inform

In May and June of 2010, the Core Team developed basic criteria for choosing the focus of an ES Assessment. The issue had to be a current and significant, and one for which ES information would be particularly informative. In addition there had to be available data to assess the issue of focus, as well as internal expertise to handle the work. The focus of the ES Pilot was chosen to be gaps in the current wetland approvals process related to residential subdivision development applications.

Between June and July 2010, discussions were conducted with wetland policy experts, regional staff and biological/ecological/economic experts from ESRD, other ministries and other institutions to scope a pilot project for applying an ES approach to contribute meaningful inputs into current wetland approval decision-making. The purpose of these discussions was to specify in a detailed manner the key issues, gaps or problems within the current wetland approvals process in order to develop a clear focus for Step 1 of the ES Approach.

Some of the key points of this discussion were:

- Currently, in the absence of an approved Wetland Policy, the guidelines approvals decision-makers can apply are the *Water Act*, the Interim 1993 Wetland Policy for private lands, and the Provincial Wetland Restoration/Compensation Guide (2007). There is a lot of discretion in this process and it is not provincially consistent.

- A number of government bodies are involved in the wetland applications, including municipalities that receive the application. They too need to be involved in this pilot as the overall approval process needed to be considered.
- Within the current process the decisions focus on compensation, and more focus should be on avoidance and minimization.
- More information was needed by decision-makers about impacts to wetlands, especially from a social and economic perspective.
- Currently, the full array of benefits that wetlands provide to humans are not accounted for in the wetland approval process.

A sub-team was then set-up to provide an understanding of the current Wetland Approvals Process to set the boundaries for the ES Pilot. The primary purpose of this sub-team was to review the approval decision making process for wetlands in Alberta and do a gap assessment of the process to which ES information could be used as an input to fill the gap. A shared and deep understanding of the policy context was important in determining how the assessment work would be organized and what questions would be asked.

The ES Pilot was specifically designed to inform the wetland approval process for residential subdivision development. Proponents submitting residential subdivision development applications that propose impacts to wetlands require provincial (under the *Water Act*) and municipal (under the *Municipal Government Act*) approvals. Wetland management on private land in Alberta is guided by the 'Wetland Management in the Settled Areas of Alberta: An Interim Policy (1993)'. Proponents submit a Wetland Impact Assessment (WIA) or a Biophysical Impact Assessment (BIA) to the municipality detailing potential impacts and any environmentally significant features for potential protection under other regulatory requirements (e.g., *Species at Risk Act*). If the municipality approves the application, proponents apply to ESRD under the *Water Act*, and wetland approval writers at the department apply the 'Provincial Wetland Restoration and Compensation Guide' to determine compensation requirements. While this is the current process, the Government of Alberta is working on a new wetland policy and it was expected that some of the ES Pilot work would be useful for guiding the development of this new policy.

The final result of this step was the prioritization of three critical gaps in the Wetland Approvals Process that the ES Pilot would address:

Questions addressed by ES Pilot

- What ecosystem services are produced by wetlands in the case study area?
- What benefits accrue to local and regional people from wetland ecosystem services?
- What trends can be observed about the condition of wetland ecosystem services over the past several decades?
- What characteristics of wetlands are critical for function and service delivery? (e.g., proximity to other wetlands, adequate riparian buffers, etc.)?
- What are the potential impacts to the entire case study area resulting from the cumulative draining of wetlands for residential subdivision development?
- Where are the 'priority' (i.e., high function and high value score) wetlands identified through WESPUS?
- What questions and/or additional information can the wetland approval writers inquire from development proponents to understand the potential losses and benefits to ES resulting from the subdivision development?
- What data, capacity and information gaps were identified?

- There is insufficient evidence to support avoidance, minimization and compensation decisions on wetlands.
- There is insufficient consideration of cumulative effects and long-term consequences of decision-making.
- There is limited ability to communicate the 'values' of wetlands.

These identified gaps needed to be translated into specific questions that an assessment could answer (see text box for examples of questions). This was a challenging exercise, as most of the people involved in the ES Pilot (both decision-makers, and the Core Team) did not have much experience with the type of information that an ES Assessment might produce. A final list of specific questions developed with decision-makers was not completed. This would be considered a key activity in future assessments, as clearly defining the work of the assessment teams is best completed early in the process.

B. Choose a case study area for assessment and decide on boundaries

The case study area was chosen for the ES Pilot to match the focus issue. ESRD's Ecosystem Services Core Team held conversations with ESRD's Approval Unit about their current approvals process and the current areas of development pressure. There was much discussion around scale, transferability of findings, and the availability of rich data, information and expertise in the area. An assessment sub-team was designed with the purpose of selecting the case study area based upon the ES Pilot charter boundaries. Team responsibilities included developing criteria to select a case study area, recommending potential locations that met criteria, documenting the case study selection process, working with other interest groups or individuals as needed, and drafting and finalizing a report outlining the case study selection process.

Membership for the Case Study Selection Team was based on potential members' expertise and knowledge of the southern part of the province and included team members from ESRD, Rocky View County, City of Calgary, Alberta biodiversity Monitoring Institute, University of Alberta, Ducks Unlimited Canada, and Alberta Innovates. In light of resource constraints, it was stressed that each task and each team must stay mindful of the objectives of the pilot. Focus for the pilot must be on current wetland approvals process only as some team members wanted to focus on the current wetland policy. This was a good test area for maintaining focus as this was the first sub-team. This *boundary was continually reiterated for all sub-teams work*.

Case study sub-team discussions focused on Southern Alberta because of:

- Large "pressure" from agriculture, urban and industrial development
- Many opportunities for "conservation" for this area
- Many wetlands
- Data is more plentiful and accessible
- Experiences more "approvals" than other areas of Alberta
- Has willing partners: Calgary's and Rocky View's knowledge and expertise

The criteria that were used to choose the case study area, based on recommendations from Ash et al. (2010) were:

- The chosen site should be relevant to current approval processes (e.g., *Water Act*, provincial compensation guide, etc.)
- Area should allow for a broad-scale modeling assessment in order to appropriate capture ES and benefits for many Albertans
- Area should allow also for a site level assessment to look at multi-scale nature of ES – there should be a minimum of three to maximum of four wetlands in the cluster in order to compare one cluster to another
- The cluster should provide locally and regionally measurable ES (sub basin and natural areas were discussed)

- The areas must provide potential for development and conservation to provide better analysis for trade-off comparisons
- There should be existing data on the study area
- The study area should preferably be contained within a basin
- The study area should include all classes of wetlands

The team chose an area in east Calgary/ Rocky View County where the Calgary ring road is proposed. The case study area covers approximately 274 km^2, encompassing part of the City of Calgary, the Municipal District of Rocky View and the Town of Chestermere (*Figure* 5). The study area is primarily agriculture (~57%), with increasing settled areas (~17%) and industrial areas (~10%).

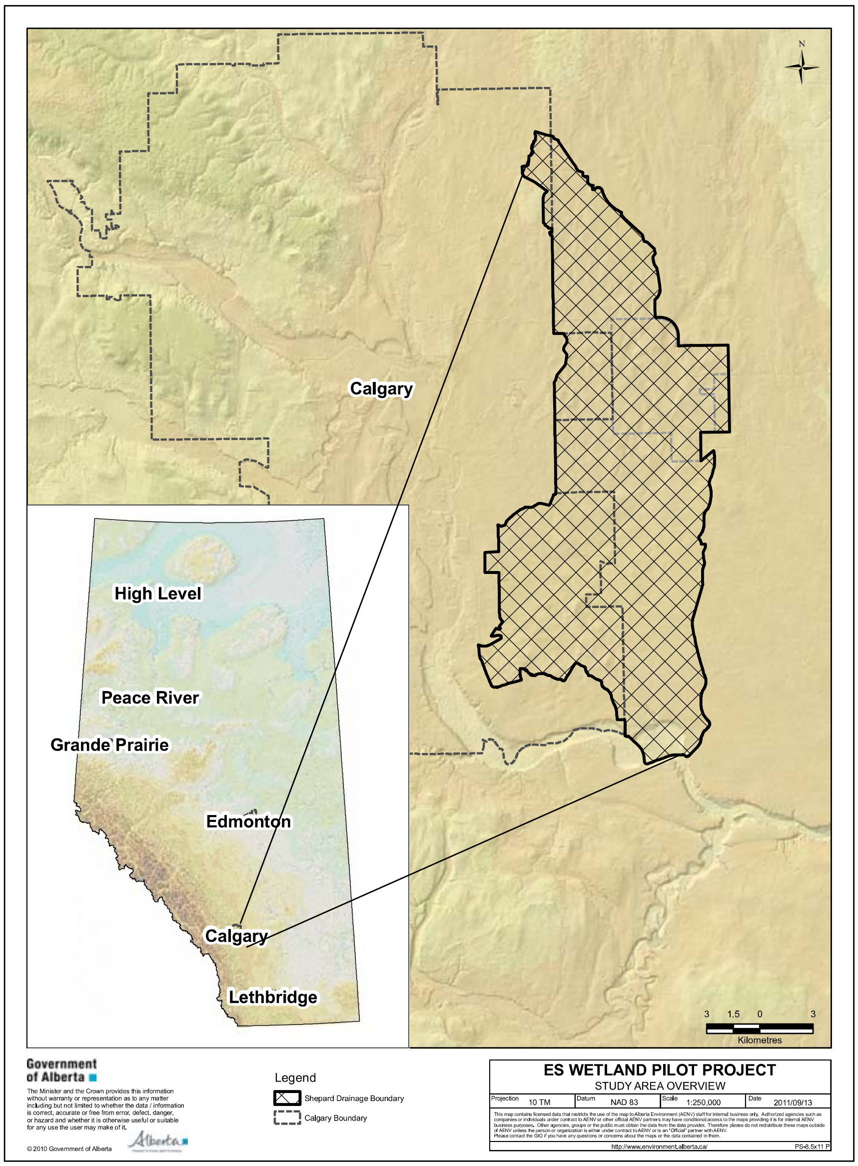


Figure 5: Case study area – wetland ecosystems in Rocky View County and East Calgary

<u>Outputs from step 1:</u>

- Clear identification of the issue to be addressed, detailed description of policy to be informed and a list of specific questions that the assessment can answer
- Boundaries determined for the study area.

Step 2: Identify priority ecosystem services to be assessed

<u>Step 2 includes 2 sub-steps:</u>

a. Identify ES produced by wetlands in pilot study area

b. Prioritize the ES that will be used in further assessment activities using criteria from decision-makers and criteria related to degree of dependencies and impacts of multiple stakeholders

Purpose of Step 2

This step involves identifying all ES produced by the wetlands in the pilot project region and determining which of these services needs to be included in an in-depth assessment of their current condition and recent trends. An assessment of all ES produced by the wetlands is not possible due to the limited scope of the pilot project. The criteria for choosing priority ES for assessment are adapted from Ecosystem Services: A Guide for Decision-Makers (WRI 2007). In order for the assessment to be relevant, credible and legitimate, this step requires a process for prioritizing ES for assessment that takes into account the ecological and societal importance of the services. This process is described in the following sub steps.

Critical Lessons Learned

- Set expectations and ensure adequate time for building shared understanding. Choosing the ES for assessment to meet everyone's expectations is challenging and there should be a time limited process put in place in order to accomplish this task efficiently.
- Select the ES based on best available information at the time and move on. Choosing the focus ES needs to be completed quickly. Comprehensiveness must be balanced with the real limitations of available resources.
- Create project specific definitions for ES. The categorization and definitions need to be context specific; in addition, shared understanding among project stakeholders can be built if they participate in exercises to develop project-specific language and definitions.
- Build a plan and have one individual manage it. Determining project steps and tasks is iterative, but having a clear work plan with all tasks and responsibilities laid out at the beginning can help to ensure that tasks are completed.
- Ensure the right approach for incorporating stakeholder feedback for how ES are impacted and depended upon. A dependences and impacts analysis could be completed in conjunction with a stakeholder workshop towards the beginning of the assessment. Core team members should be involved and responsible for this step. A desktop analysis by local experts could also serve to accomplish this task.
- Build a database of all groups, communities, organizations and businesses that depend upon or impact ES as a useful exercise to identify sources of information for the assessment.

- Data compilation should be strategic to avoid collecting and storing data that will not be used. A team responsible for data management might be useful for this purpose. Bring together data owners to discuss the availability, relationships between data, and potential limitations associated with the data.

A. Identify ecosystem services produced by wetlands in pilot region

Ecosystem services, as defined by the Millennium Ecosystem Assessment (2005) and as adopted by the pilot project, are "the benefits people obtain from ecosystems". This definition includes both direct and indirect benefits, as well as benefits that people know about (e.g., clean water), and those they may not know about (e.g., flood protection).

ES can be considered an instrumental 'means' to the 'ends' of human well-being (Costanza, 2008).

According to the MA definitions (2005):

- **Provisioning services** are the products obtained from ecosystems including food, fibre and fresh water.
- **Regulating services** are the benefits received from the regulation of ecosystem processes, including the regulation of climate, water and human diseases.
- **Cultural services** are the non-material benefits people obtain from ecosystems through spiritual enrichment, education, recreation, and aesthetic experience, including knowledge systems, social relations and aesthetic beauty.
- **Supporting services** are necessary for the production of all other ES. Examples include nutrient cycling, soil formation and primary production.

Ecosystem services from all four categories are produced by wetlands and their surrounding areas. Lists of ES produced by wetlands and surrounding areas found in literature were used to begin the process of identifying ES produced by wetlands in the case study area. Local experts were then consulted to identify which ES are produced within the case study area. *Table 2* presents ES produced by wetlands, according to the literature (MA 2005). The second column identifies the services that are produced by wetlands and surrounding landscapes within the study area, as identified by local experts and previous projects conducted in this region (Biophysical Impact Assessments, Stormwater Management Plans, Open Space Inventory). A complete list of important project documents and reports is compiled in *Appendix A*.

Table 2. Common ecosystem services produced by wetlands and ES hypothesized to be produced by wetlands in study area

ES from Wetlands	ES from Wetlands in Study Area
Crops	X
Fisheries	
Freshwater	X
Carbon Storage	X
Groundwater Recharge	X (some areas)
Water for agriculture and	X (cattle ranching)
Industry	X
Water Purification	X
Flood Control	X
Recreation	X
Tourism	X
Cultural Value	X
Sediment Retention	
Hydropower	X
Nutrient Cycling	X
Pollination	

B. Prioritize the ecosystem services that will the focus of further assessment activities using criteria from decision-makers and criteria related to degree of dependencies and impacts of multiple stakeholders

The first criterion for selecting ES to include in the assessment is their relevance to stakeholders. Through discussion with decision-makers and experts, the ES Pilot identified four core ES of most relevance to target decision-makers. These four ES emerged from the ES dependencies and impacts analysis as being relevant to multiple stakeholders (including developers), and potentially highly impacted by development and land cover change. Flood control, water filtration, and water supply were hypothesized as contributing to the well-being of everyone living and operating in the pilot study area, as well as to economic development. Carbon storage was identified as an ES of management priority for the Government of Alberta. Assessing the actual impacts and dependencies of stakeholders on these core ES became the focus for the Biophysical Team and Economic ES assessment activities.

Ecosystem Service	Definition
Flood control	The timing and magnitude of runoff, flooding, and aquifer recharge can be strongly influenced by changes in land cover, including, in particular, alterations that change the water
Water filtration (water quality)	The filtration and decomposition of organic wastes and pollutants in water; assimilation and detoxification of compounds through soil and subsoil
Water supply	Storage and retention of water for domestic, industrial and municipal water use
Carbon storage	Storage of and sink for greenhouse gas emissions

Expanded list of ecosystem services for assessment

With encouragement from the project Steering Committee and additional external experts, the list of ES for assessment was expanded to include other ES of relevance in the pilot project region. This decision was based on several factors:

- Decision-makers need to know the full set of ES provided by the wetlands in the pilot project region in order to understand the importance of managing wetlands strategically.
- Increasing the awareness of decision-makers to the multitude of ES and their benefits, and to how multiple ES interact, can improve management decisions.
- While the scope of the pilot project is limited, providing as much information as possible on a longer list of ES is desirable, acknowledging that some ES will be assessed in more depth than others and that the core ES will be given priority for assessment resources.

Is 'Biodiversity' an Ecosystem Service?

The ES approach is a "utilitarian" concept of nature, and biodiversity is a necessary condition for the production of ES (Ash et al. 2010). Furthermore, according to the World Resources Institute (2008) and the Millennium Ecosystem Assessment (2005), biodiversity is not an ES, but instead is a 'response variable' that is affected by changes in climate, resource availability and disturbance. Biodiversity underpins the supply of ES such as seed dispersal, pollination, pest and disease control, and carbon sequestration. In addition, the intrinsic value some people place on biodiversity is captured under the cultural ES called "ethical values".

The pilot project did not include biodiversity as a separate category of ES. It was measured and reported on as it relates to the provision of specific ES. The dependencies and impacts on biodiversity materialized through one or more of the ES, although an analysis of this was not a focus of the ES Pilot (WRI, The Corporate Ecosystem Services Review).

Table 3. List of all ES included in ES Pilot

Ecosystem Service	ES Pilot Definition	Beneficiary Group in the Case Study Area	Sub-Group
Water supply and storage	Storage and retention of water in wetlands for domestic, industrial and municipal water use	Agriculture	Livestock, Crops
		Residential dwellings	Home owners, Developers, Municipalities
Carbon storage	The stock of organic carbon stored in soils for Class 3, 4 and 5 wetlands. *Note: Class 1 and 2 were not included due to methodology limitation.*	Albertans	Not applicable
Flood control	The timing and magnitude of runoff and flooding can be strongly influenced by changes in wetlands	Residential dwellings	Home owners, Developers, Municipalities
Water filtration/ purification	Role ecosystems play in the filtration and decomposition of organic wastes and pollutants in water; assimilation and detoxification of compounds through soil and subsoil.	Agriculture	Livestock, Crops
		Municipalities / Government	Rocky View County, Calgary, Alberta government
		residential	Municipalities, Home owners, Citizens
Recreation and tourism	Providing opportunities for recreational activities. Including: eco-tourism, sport fishing and other outdoor activities	Recreation Groups	Birders/ Botanists/ Hiking
		Tourism	Local/ Provincial/ Other
Heritage	The value that individuals place on knowing that a resource exists, even if they never use that resource	First Nations	First Nation groups
		Settlers, Citizens	Historic associations/ societies, Sense of place
Science and educational value	Ecosystems and their components and processes provide the basis for both formal and informal education in many societies	Education Groups	Schools/ Government Outreach/ ENGO Outreach
		Science	Schools/ universities/ Research groups
Food/ crops	That portion of gross primary production extractable as food for human and/or cattle production	Agriculture	Farmers
		Public	Buyers/ Grocery stores
Aesthetic	Beauty and enjoyment provided by landscapes with wetlands	Citizens	Local, Recreation and Tourism groups
Erosion control	Retention of soil within an ecosystem. Role ecosystems play in retaining and replenishing soils.	Residential	Home owners, Developers, Municipalities
Pollination	The fertilization of floral plants	Agriculture	Farmers, Buyers/ Grocery stores
Soil Formation	Process by which organic material is decomposed to form soil.	Agriculture	Farmers
		Residential	Municipalities, Home Owners, Citizens

Impacts and Dependencies of ES

The decision-makers targeted by this assessment were considered to be the first priority for determining ES relevance; however, these decision-makers must take into account the needs of other stakeholders when making decisions about wetlands that impact ES. The ES dependencies and impacts analysis (WRI 2008) was thus tested in an attempt to provide a qualitative estimation of the relative importance of ES in the Shepard Slough area to stakeholders such as residents, developers, visitors and decision-makers. According to the WRI, "a systematic dependency/impact analysis increases the likelihood of uncovering unforeseen impacts (positive or negative) or dependencies" of a decision, plan or project (WRI, 2008). This step does not entail quantifying or providing evidence of the dependencies and impacts of stakeholders related to ES, which can only be accomplished after the ES and their relationship to human well-being has been assessed (Step 3). This step is designed to narrow down the focus of the assessment to those ES that are most relevant to key stakeholders, based on already-held knowledge of the system.

The ES Pilot initiated but did not complete this activity due to time constraints and the late timing of the activity. The results used to illustrate this section are therefore not final in any way and service only to demonstrate what the activity entails. The assessment team began this step with the long list of ES based on the previous step, and identified the stakeholders that depend on and impact each service. Dependencies and impacts were identified through knowledge of the system, stakeholder consultation, previous ES studies in Southern Alberta and expert review. Particular attention was paid to the dependencies and impacts of residential sub-division development, as this is the focus of the project's target decision-makers (Table 4). However, dependencies of all stakeholders were identified, as well as impacts from other activities and drivers of change (exercise incomplete, results not shown).

Ecosystem services that are depended upon and impacted by residential subdivision development were highlighted, as it is to the benefit of developers and regulators to decrease losses in these ES.

The project team screened ES dependencies and impacts using the following criteria and questions (from WRI 2008):

- A development project depends on an ES if the service serves as an input or if it enables, enhances, or influences the conditions necessary for a successful outcome for the project.
  - There is high dependence if no cost-effective substitute for the service exists.
- A development project impacts an ES if actions associated with the project alter the quantity or quality of a service.
  - Does the impact limit or enhance the ability of other to use or benefit from the ES?
  - Is the project's impact a large share of the total local or regional impacts on the ES?
  - Is the ES in short supply relative to demand?
  - Could the project's impact push the ES across biological thresholds that lead to scarcity of the service?

Table 4. Impacts and Dependencies of ES in relation to residential subdivision development

			cost-effective substitute?	does project limit/enhance others use?	is project's share of impact large?	is ES in short supply relative to demand?	Could there be a threshold approaching?
ECOSYSTEM SERVICES	**DEPENDENCY**	**IMPACT**					
water supply and storage	X	X	yes	limit	important	yes	yes
flood control	X	X	costly	limit	important	yes	yes
water purification	X	X	costly	limit	important	yes	yes
carbon storage		X	N/A	limit	important	yes	unknown
pollination		X	costly	limit	important	unknown	unknown
soil formation, erosion control	X	X	costly	limit	important	unknown	unknown
food/crops		X	yes	limit	important	no	no
recreation and tourism		X	other locations	mixed	unknown	unknown	unknown
heritage value		X	no	unknown	unknown	unknown	unknown
science and education opportunities		X	other locations	limit	unknown	unknown	unknown
aesthetic opportunities	X	X	other locations	mixed	important	unknown	unknown
NOTE: Pink colour highlights ES that the project both depends on and impacts							

Data Compilation

Due to the need for the same data within different teams, all data compilation was organized through the Core Team. The GIS team member was the repository for all data and was responsible for helping teams with figures, maps and GIS analyses. Team members were told to send any 'relevant' data to the GIS lead, which led to a large amount of data and information stored that wasn't used or useful to the pilot. Given the novel nature of the pilot, the lack of experience in undertaking ES assessments and the current process and type of environmental and ecological data monitoring and collection ES data, it was considered a lesson learned about data compilation, as no one person knew enough about what was needed to set strong criteria around data collection needs. Data and information was collected continually throughout the pilot as new sources were found.

<u>Outputs from Step 2:</u>

- Core list of ES for in-depth assessment, and rationale behind choice
- Longer list of ES for qualitative or quantitative assessment, ranked in order of relevance to stakeholders (using dependency/impact criteria)
- Preliminary compilation of data relevant to ES assessment

Step 3: Assess condition and trends of priority ecosystem services

Step 3 includes 3 sub-steps:

a. For priority ES, choose indicators linked to the production and/or consumption of the service that are relevant to decision-makers and other stakeholders.

b. Develop and implement methods for assessing the current condition of each service (assessed in relation to a baseline condition or to an ecological or societal threshold) and recent trends in the service (rate of change, positive or negative).

c. Identify drivers of change acting on priority ES and assess trends in drivers.

Purpose of Step 3

This step involves assembling data and assessing the condition and trends in ES that development projects depend on and impact. Because ES are impacted by direct and indirect drivers of change that interact with development plans, these drivers are also assessed. The resulting information will be used to identify the ES-based risks and opportunities associated with development projects, information that will help decision-makers reduce trade-offs in their decisions. Appendix 1 provides a reference of a number of methods and approached that could be considered for this step.

Critical Lessons Learned

- Conduct a literature review as the first step towards identifying indicators and methods for assessing ES.
- Have the right skills and competencies involved. The assessment of each ES needs to be led by an individual or team with expertise in the specific science of that ES. Complementarily, individuals with an understanding of the relationship between ES are valuable to ensure cross-pollination of assessment methods.
- Develop multi-disciplinary teams to conduct the work. In order to promote a complete assessment of the production, value and benefits associated with each ES, a multi-disciplinary team could be formed for the assessment of each ES.
- Act even without complete data. Complete data for ES assessment is rarely available. Data available to understand the condition and trends of ES might refer to natural assets on the landscape, ecological functions, the actual services provided to humans, or the benefits that people get from ES. Indicators for any of these system components may be useful for understanding ES.
- Make the link to human well-being. The assessment of ES is different from the assessment of natural resources in that it is important to determine what aspect of the ES is relevant to human beneficiaries. For example, the amount of water stored on a landscape may be less relevant than the amount of water stored that is accessible to people. For this reason, the choice of indicators is context dependent.
- Understand the link between drivers and impacts first (compiling necessary supporting material for changes in ES), and then tailor the assessment. A scientific assessment of drivers of change (i.e. factors such as demographic or political change that are responsible for changes in land use or land management) is important for understanding the most pressing issues that may affect ES and human well-being.

A. For priority ecosystem services, choose indicators linked to the production and/or consumption of the service that is relevant to decision-makers and other stakeholders

In Step 2, data compilation was initiated, and was continued in this step. The GIS team lead was the repository for all spatial data and information, such as census data. The GIS lead was also the conduit for getting and receiving data for and from the biophysical assessment consultants. Appendix 2 presents all the biophysical and some general data layers collected for the pilot project. All team members sent the GIS lead data or information they thought might be useful, although ultimately the pilot used a fraction of the data collected.

Indicators for priority ES were compiled from literature, databases and reports. *Table 5* lists the data sources that were mined for both data and indicator options. The ES Pilot organization purposefully had all three key decision-makers sitting on both the Steering Committee and an ad hoc decision-maker group so that the team could access them to gather information on the current condition and trends in the area and access detailed reports that contained information on the condition and trends in the region.

Table 5. Principal Data Sources used in ES Pilot

Data/Indicator Source	Details
Alberta Environment and Sustainable Resource Development's SDE database	Geographic Information Office
Government of Alberta Ministry databases	SDE, Agriculture, Parks, Energy, SRD, Office of Statistics
Online databases	GeoBase, NRCan, Statistics Canada
Datasets from external contractors and organizations	City of Calgary, Municipal Districts, O2 Planning and Design, NAWMP, DU
Millennium Ecosystem Assessment, Ash et. al. (2010), TEEB (2010) and WRI (2008), IUCN 2010 Wetland Assessment Guide	For guidelines and examples of indicators
City of Calgary	Biophysical Impact Assessments, Community Services and Protective Services 2011 Civic Census Results Interactive Maps: Community Social Statistics Property Assessment Database, Calgary Annexation Territory Open Space Study
LiDAR	1 m2 LiDAR data of the case study area
Shepard Regional Drainage Plan	Rocky View County, City of Calgary and Town of Chestermere

Indicators for ES can refer to the natural assets, ecological functions, actual services, or benefits from services. This was at first confusing to the different ES Pilot teams, who developed diagrams of how these system components fit together to develop common understanding of how to order and assess the system components (see *Figure 6*). Because data is often limited for assessing ES, indicators for any of the system components might be used to assess an ES.

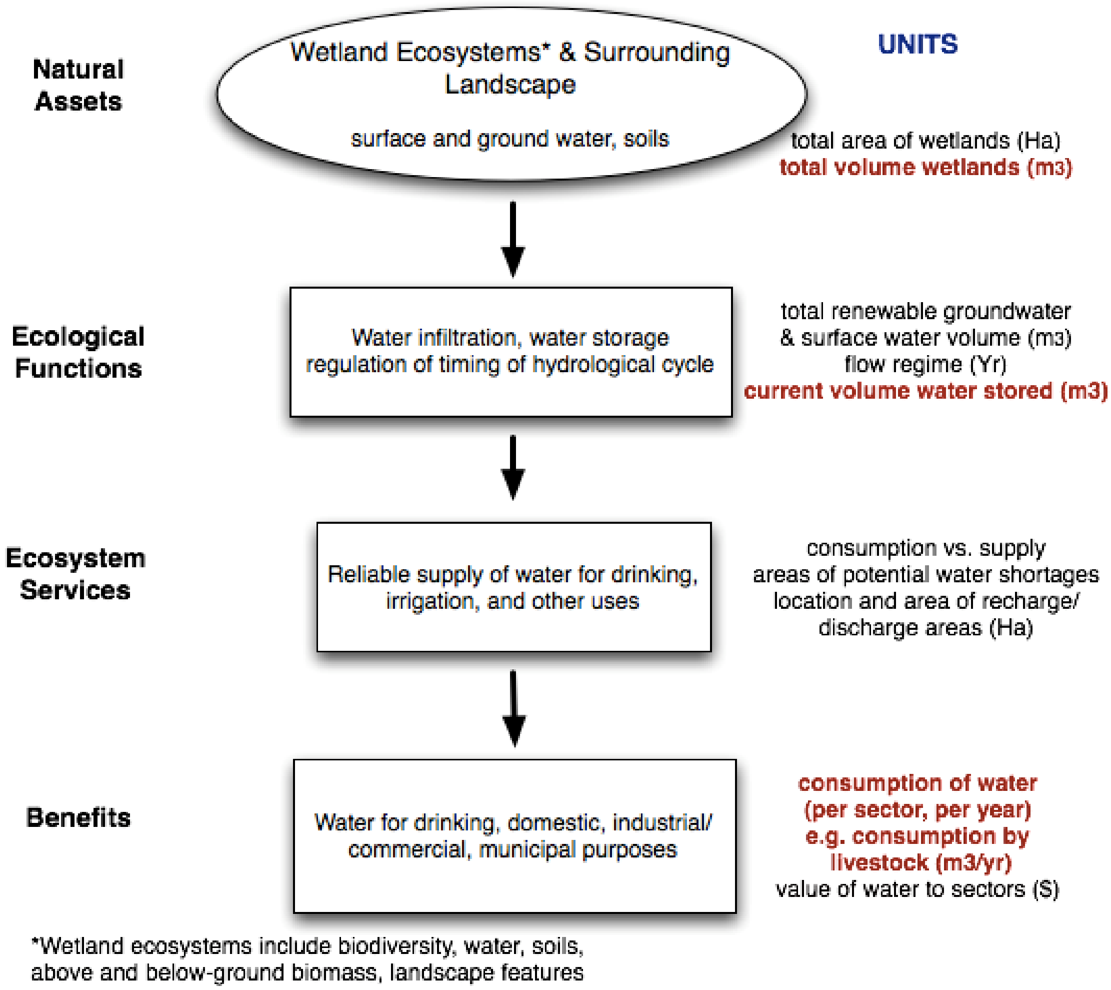


Figure 6: Indicators chosen to assess water storage in wetlands are shown in red. This diagram demonstrates how ecosystem processes and natural assets produce ES, which benefit human well-being in different ways. An important step in understanding how ES are produced in the region's wetlands is to try to understand how these linked processes occur. It is not always possible to establish how ecological processes translate into ES or human well-being, but attempting to understand this system is key to eventually deciding what parts of the system can be assessed and what indicators of the service or underlying process should be used in the assessment.

The cascade diagrams, developed for all the focus ES and several others, focused discussion across ES Pilot teams on which indicators were most appropriate for answering the questions of decision-makers, for which was there available data, and how the economic sub-team could build on the biophysical indicators to provide economic values associated with individual ES. Ultimately, consultants were hired to conduct the biophysical ES assessments, and chose indicators with input from the Biophysical sub team at a late stage in the assessment. Indicators were chosen based answers to three questions – what do we need to know about the system in order to tell a story about how ES are currently being produced, how this is changing, and how are the benefits to humans from each ES are changing?'

Final indicator choices depended on data availability and consultant expertise. In future ES assessments, it would be recommended that more detailed questions to focus the assessment be developed in the early stages, and that indicators would be chosen early in order to allow for integration of data, indicators and scales across ES assessments and across disciplines.

B. Develop and implement methods for assessing the current condition of each service (assessed in relation to a baseline condition or to an ecological or societal threshold) and recent trends in the service (rate of change, positive or negative)

The condition assessment provides a 'snapshot' of the current state of the wetland ES in the study area at a particular time. Condition is not synonymous with 'health', 'integrity' or 'degradation' of ecosystems, though all of these related concepts may be part of an ecosystem condition assessment (Ash et al. 2010). Ecosystem service condition can be measured by assessing the yield, the stock that permits the yield, or an attribute that permits the provision of services that have no yield.

Ecosystem service trend assessment involves analyzing the change in ES condition over time. The temporal scope of a trend assessment generally focuses on the 'relevant past to the predictable future' (Ash et al. 2010). The goal of looking at recent trends in ES is to determine whether they are increasing or decreasing, and at what rate of change. This information can also be used to measure cumulative change. For the purposes of the pilot project, trends were measured from data collected in the 1960s, to 2001, to currently (~2010-2011). Because ES exhibit some path dependency, rates of change calculated from data collected over the past several decades can be used to extrapolate trends for short periods into the future, although this was not done explicitly in the ES Pilot.

In order to develop condition and trend information, individuals or teams were charged with developing methodology for assessing each ES, based on the best science available. Where possible, methods that had already been tested in Alberta were used to assess ES. Multiple consultants were hired to conduct the biophysical assessments of the four focus ES, which meant that the results across ES were difficult to compare and integrate. In addition, the consultants were allocated very little time to complete their tasks, and thus the methods used were simpler than might otherwise have been developed given more time. There are a number of suggestions in Section 3 of this report about how the assessment work around ES could have been organized differently.

The Core Team recognized that there were a number of assessment methods and potential models being used to develop ES information for assessment. Because the team had limited experience and capacity with ES modeling, and relatively time with international experts to develop methods, the ES Pilot organized a workshop to look at options for modeling both for use in the ES Pilot and in the longer term to inform the ES Program on potential useful applications. From this workshop the possibility of using the rapid assessment tool WESPUS (The Wetland Ecosystem Services Protocol for the United States) emerged (see number 6 below for more information about WESPUS).

The assessment made use of GIS data and modeling to describe the current state and past trends of ES in the study area. Approaches for assessing each ES are described below, and complete methodology is described in separate technical reports.

1. Water storage

All wetlands in the study area were assessed for water storage functions. Two steps were used to determine total water storage capacity of each wetland: (1) the existing water volume in wetland was calculated using the equation Volume (m^3)=2850 X Area$^{1.22}$ (Manitoba Conservation et al., 2000); and (2) additional wetland water storage capacity was calculated (i.e., the total capacity of the wetland when full using the mean elevation of the boundary of the wetland and subtracting the maximum water level). The water storage capacities of individual wetlands were calculated by applying 1m grid LiDAR data in combination with a rating curve. The LiDAR data set was acquired during very dry periods in late fall (between 2007 and 2009), which results in a conservative estimate of water storage capacity.

A landcover dataset was created for the ES Pilot using data from DUC, the Calgary-Rocky View County Intermunicipal Development Plan (IDP) and Geobase land cover classification, all from a period between 2005 and 2008. Watersheds were delineated using LiDAR and WHITEBOX™ remote sensing methods in addition to previous delineations (e.g. City of Calgary's "storm subcatchments").

Full methods for the assessment of water storage are reported in the Water Storage Technical Report. A limitation of the method used was that the connectivity between wetlands was not investigated in terms of the relationships among wetlands to maintaining water on the entire landscape. The impact of wetland removal on surrounding wetlands was not investigated.

2. Flood control

Flood control was assessed using a modeling approach based on the Industrial Heartland GIS model developed in Alberta by Cobbaert et al. (2011). Several modifications and improvements were made to account for study area characteristics and to be able to estimate peak flow (m^3/s) reductions. In order to estimate flood control, values for water storage capacity (H1, m^3), area of impervious surfaces (H2, %), wetland catchment size to wetland ratio (H3), amount of upslope wetlands (H4, %), wetland position in watersheds (H5a, quartiles) and subwatersheds (H5b, quartiles), connections to surface waters through natural or artificial drainage systems (H6, presence-absence outflow), and subsurface storage potential (H7, score out of 4 based on vulnerability maps) were calculated for each wetland in the study area. Full methods used for calculating all values are provided in the Flood Control Technical Report. Values for each of these variables were combined to estimate flood control, using the following equation:

Wetland Index of Flood Control

$$\frac{H1 + H2 + H3 + H4 + H5a + H5b + H6 + H7}{8}$$

A limitation of the modeling approach used was that it was difficult to locate where on the landscape flood control was lacking, or leading to impacts on human well-being. It was also difficult to interpret whether there were areas on the landscape that are particularly important for flood control, or even where flooding is currently an issue. The model output shows the potential of each wetland to provide flood control, which is a useful parameter, but perhaps not specific enough for decision-making. More complex hydrological modeling and monitoring of flood events could be combined to offer more detailed information.

3. Water purification

The assessment of water purification in this pilot project focused on the potential of wetlands to remove sediments and nutrients (i.e., nitrogen and phosphorus) from a water supply. The Wetland

Purification Score, calculated for all wetland complexes in the study area, is based on an index derived from eight[3] metrics that describe water purification potential:

- Wetland area; total area of wetlands within a wetland complex (WP1, hectares)
- Pollutant sources; percentage of wetland contributing area that is under urban land use (WP2)
- Pollutant removal opportunity; index of wetland area to wetland contributing area ratio, percentage disturbed land, and wetlands upslope of wetland complex (WP3)
- Pollutant transport potential; mean slope of wetland's contributing area (WP4)
- Potential significance of purification; distance from wetland complex to stream/river (WP5)
- Recharge potential; position of wetland complex in catchment (WP6)

The metrics were determined using satellite imagery (LANDSAT TM), climate data (LANDSAT TM), a digital elevation model (LiDAR), zonal statistics in ArcGIS and LiDAR data collected in the Fall (2007-2009). Wetland inventories were completed for 1990, 2000 and 2010 using LANDSAT TM, choosing periods with similar climate conditions[4]. Full modeling methods are available in the Water Purification Technical Report.

The Wetland Purification Score (WPS) was determined using the following formula:

Wetland Purification Score

$$\frac{WP1 + WP2 + WP3 + WP4 + WP5 + WP6}{6}$$

A limitation of the modeling approach used was its inability to assess whether wetlands were actually contributing to water purification and in what ways. The model assessed the potential for wetlands to purify water, using only a few basic parameters. This was chiefly because of a lack of time allocated to the assessment of water purification and a more complex model was actually developed but not used due to time and data sharing constraints. Decision-makers would have benefited from information about the role of riparian zones in water purification, the areas on the landscape that make the most use of wetlands for water purification, and information about current water quality and its relationship to wetlands.

4. Carbon storage

Carbon storage associated with Steward and Kantrud Class III (seasonal), Class IV (semi-permanent), and Class V (permanent) wetlands in the Sheppard Slough Drainage Catchment was assessed. Class I and II were omitted due to project limitations and costs. First, the stock of carbon contained in existing wetlands within the case study area was estimated, and then the

[3] A more advanced, and potentially accurate, model was also developed using 39 metrics, however, the data was not available within the timeframe of the pilot assessment. The more advanced model includes metrics for riparian vegetation, soil composition, surrounding land cover, surrounding land use, groundwater vulnerability, and many more.

[4] For future ecosystem service assessments, it is recommended that a combination of LiDAR, Landsat/SPOT, and SAR imagery are used to map wetlands (both inundated (open water) and saturated areas), and determine their spatial and temporal dynamics over changing climatic conditions and response to human activities. This was not possible for the ES Pilot.

amount of carbon dioxide re-emitted to the atmosphere as a result of wetland loss between 1962 and 2005. Full methods for carbon storage assessment are provided in the Carbon Storage Technical Report, and summarized below.

In order to estimate carbon stocks, wetland inventories for two periods were constructed. A current wetland inventory was derived from aerial photographs taken in the 2005 growing season. An historic wetland inventory was derived from stereo photographs taken in June 1962. Wetland carbon stores were estimated for Class 3, 4, and 5 wetlands in the case study area based on previous research conducted on wetlands in the Canadian prairies, where Badiou et al. (2011) observed soil organic carbon concentrations (SOC) of 205 Mg C ha^{-1} in reference wetlands. To conservatively estimate the amount of carbon re-emitted back to the atmosphere as a result of wetland loss in the Sheppard Slough Study Area (specific to class 3-5 wetlands) we applied an SOC loss of 89 Mg ha^{-1}, as not all soil organic carbon is lost during drainage. This factor is taken from Badiou et al. (2011) and was estimated from the differences in SOC concentration between intact wetlands (205 Mg SOC ha^{-1}) and recently drained wetlands (116 Mg SOC ha^{-1}).

5. Other Ecosystem Services

All other ES included in the ES Pilot biophysical assessment were investigated using a desktop literature review.

6. WESPUS

The Wetland Ecosystem Services Protocol for the United States (WESPUS) was identified by ESRD as a tool with the potential to help address identified gaps in the current regulatory context surrounding wetlands. WESPUS is a rapid assessment site-level tool that scores a wetlands ability to provide multiple ES and scores the relative value of these ES to nearby populations. The purpose of the WESPUS component of the pilot study was to identify the potential applicability of WESPUS for assessing ES from wetlands in Alberta, and to provide a site-level assessment of ES in study area wetlands. Other objectives included the identification of potential limitations and required changes to the WESPUS protocol that would need to be made prior to more widespread application of such a method in the province.

WESPUS is intended for all of temperate North America and models over 16 ecosystem functions, including, among others:

- water storage and delay
- sediment retention
- phosphorus retention
- nitrate removal
- carbon sequestration
- aquatic invertebrate habitat
- amphibian and reptile habitat
- waterbird feeding and nesting habitats
- songbird, raptor, and mammal habitat
- pollinator habitat
- native plant diversity

WESPUS required field visits to each site combined with desktop assessments to complete ratings for 140 criteria. Outputs of the WESPUS Excel spreadsheet include a number representing the relative effectiveness of each function, as well as the relative benefits for humans associated with each ecosystem function.

WESPUS output is divided into two categories – function and value. Function scores determine the capacity of the wetland to perform specific functions that may be desirable to humans. Value scores determine the relative benefits that humans actually get from specific functions. As an example, a wetland may have a high score for water storage and delay, but may have a low score for the value of this function if there are no populations nearby to benefit from the wetland's ability to control flooding.

Further work is needed to adapt WESPUS to the Alberta context. In addition, a regional version of WESPUS that would allow for a GIS-based assessment of larger areas on the landscape is in development and could prove to be a useful tool for decision-makers.

C. Identify drivers of change acting on priority ecosystem services and assess trends in drivers

Simultaneous to the assessment of ES conditions and trends, some information was developed about the pilot project system and drivers of change acting within it. Information on trends in drivers of change is needed to understand what changes are occurring in the system and affecting ES and benefits to human well-being. Without knowing what is driving a change within a system, it is difficult to determine how to respond to changes in ES that affect human well-being. In addition, assessing changes in the natural assets that compose the wetland system (including water resources, wetland ecosystems and biodiversity) allow us to understand how trends in land cover and land use are affecting ES.

Information was collected from GIS datasets about demographic and land cover changes, however, not in a systematic or consistent way as there was no individual or team responsible for this component of the assessment. The Core Team had each of the three assessment teams (biophysical, economic and socio-cultural) collect relevant information on drivers as they did their research. In particular, the economic sub-team collected statistics and other information from the relevant reports for the study area. Decision-makers, all of whom live in the case study area, also provided judgment and expertise about the drivers of change in the region. Interviews with the decision-makers were recorded and uploaded to the sharepoint site so that other team members could review them. While this information was not gathered in a systematic manner, it was captured throughout four sessions with them and in individual interviews. It is recommended that future ES assessments complete a systematic, scientific assessment of current trends in important drivers in order to understand the underlying factors that are leading to changes in ES and identify issues that need to be addressed through management interventions.

Step 4: Evaluate economic and socio-cultural benefits to human well-being from ecosystem services

For priority ES, develop information on how stakeholders benefit from, and explicitly value, ES from economic and socio-cultural perspectives.

Purpose of Step 4

The purpose of this step is to draw the link between ES and human well-being. Until ES are linked to some aspect of development, human health or general well-being, an assessment is not truly about ES, but rather about resources or natural assets. It is the explicit identification of ES beneficiaries that enables us to allocate value to ES.

Critical Lessons Learned

- A literature review is a first step towards identifying links between wetland ES and human well-being
- Economic valuation is just one tool to establish this link. Results of economic valuation studies should be reported with caution, as results are often more illustrative than precise.
- Social science approaches are useful in establishing how people in a certain area value ES
- Biophysical assessments should be designed to also be relevant to establishing the link between ES and human well-being. For example, a biophysical assessment can determine where on the landscape people are most at risk from flooding and how large the risk is.
- All research components should be designed to answer specific questions determined at the beginning of the assessment with the key decision-makers

Investigation of the links between ecosystem services and human well-being

The ES Pilot was mandated to develop relevant economic information to demonstrate dollar-value benefits that humans get from ES. A socio-cultural evaluation was conducted to collect social science information on how ES are valued by people in the study area. Brief methods on how information on the value of each ES to humans was developed are provided below, and complete methodology is included in separate technical reports (Economic and Socio-Cultural). First, the methods used to establish the general value of multiple ES is described.

Rank values of multiple ES

Ecosystem service benefits are context specific, as they relate to how the environment is used and valued as to how services are produced by ecological processes. It was therefore important to understand how stakeholders in the study area value ES. The socio-cultural team sent out a survey to garner perspectives on wetlands in the case area. A total of 3000 surveys were sent randomly to people in the case study area and approximately 200 responded. The survey design is provided in the Socio-Cultural Technical Report. Questions asked of the survey respondents were based off a survey derived from Boxall and McFarlane's (2000) forest values survey; note, however, that in any place the word 'forest' was found it was replaced with 'wetland'.

The ES Pilot also conducted a workshop in August 2011 to gain the perspectives of key stakeholders about their perceptions of the relative importance of each ES. A specific goal of a workshop with stakeholders was to understand perspectives on cultural ES, which are challenging to assess. Stakeholders were asked to rank the twelve ES included in the ES Pilot in terms of their importance to individual stakeholders, of their importance to the stakeholder group that each individual represented, and of their perceived importance to society as a whole (*Table 6*). More information about the workshop and approaches used with stakeholders are also included in the Socio-Cultural Technical Report.

Table 6: Rank order of benefits from ES organized by their perceived importance to the individuals, their stakeholder group, and to society. One is the highest ranking and twelve is the lowest ranking.

	Individuals	Stakeholder Group	Society
Water filtration/purification	1	3	1
Aesthetic (beauty and enjoyment)	2	6	8
Water quantity regulation	3	1	1
Flood control	4	2	3
Science and Educational Value	5	8	10
Recreation and tourism	6	5	5
Erosion control	7	4	4
Pollination	8	11	5
Food Crops	9	7	10
Soil formation	10	10	7
Carbon storage	11	12	8
Traditional Use	12	9	12

The following section presents the overall methods and results of the economic sub-team assessments. For each of the ES assessed, the full economic methods are available in the Economic Technical Report.

1. Water Storage

A literature review was conducted to determine known links between water storage in wetlands and human well-being. Water use in the study area was investigated, including surface water licenses held in the area. The use of water from wetlands by ranchers for watering cattle was investigated, and the total potential withdrawal of water by the current number of cattle in the study area was calculated.

2. Flood Control

Instances of flooding and flooding concerns were investigated for the study area. The contribution of wetlands to maintaining water inputs into the Bow River were calculated based on current and projected flow rates and used several methods. Past financial investments into flood control infrastructure were tabulated in order to determine the value of flood control to communities.

The cost of replacing natural wetlands with built infrastructure was investigated by the ES Pilot to determine the total economic benefits provided by wetlands in the study area. This type of analysis provides an idea of how much society would have to pay to replace natural flood control with build infrastructure. The economic benefits of wetland flood control were evaluated based on data available from the Shepard Constructed Wetland. Multiplying the per-hectare value from Shepard Constructed Wetland to the estimated 1,339 hectares of wetlands yielded a replacement cost of about $338 million. This corresponds to an estimated $2 million per year in economic losses if the historic rate of wetland loss is applied (0.6% between 1960 and 2005).

Wetland restoration costs are considerably less than the cost of constructing artificial wetlands of the same size (Tracy Scott, 2011). The restoration costs of existing wetlands are calculated based on the total wetland area of 2,450 hectares multiplied by the average restoration cost of $17,500 per ha at the site of restoration for the Calgary area. This yielded an estimate of $43 million for total restoration costs.

Using historic (1962 to 2005) annual loss of approximately 0.6% (Badiou, 2011a), the restoration cost was estimated at $257,250.

Another way to evaluate the benefits provided by wetland flood control is to examine damages incurred by flood events. As a large proportion (57%) of the case study area is agricultural, flood risk is a major concern. From 2000 to 2010, total insurance payments to agricultural operations amounted to $385,715 for loss due to flood damage, including $191,991 for the unseeded loss in the spring as a result of too much moisture and $193,724 for flooded loss in the fall during harvest (Rob Cruickshank, 2011).

3. Water Purification

In the study area, wetlands are being modified for nutrient management or replaced by water treatment plants and constructed wetlands and stormwater ponds. Calculating the replacement cost of constructed or modified wetlands and water treatment plants is a method for determining the value of water purification by wetlands to humans.

For the economic assessment, the pilot estimated the cost of conventional water treatment, constructed wetlands and wetland restoration. Initial construction costs of treatment wetlands are relatively low compared with traditional water treatment systems. Because wetlands require little maintenance, long-term costs are also quite low. The cost of the constructed wetland is proportional to the number and sizes of treatment cells required, generally about 50% to 90% less than conventional treatment techniques (White, n.d.). For the study area, the treatment costs of phosphorus and nitrogen (in terms of $/kilogram) were not available, nor were local data for how much phosphorus and nitrogen a typical wetland in the area can absorb (amounts depend on the particular type of wetland, its location and plant composition, and the chemical and physical characteristics of the soil).

The pilot used conservative estimates from a North American database that have been used previously in the study area: 80.3 kg/ha/yr for phosphorus, and 547.5 kg/ha/yr for nitrogen. The cost of phosphorus treatment was estimated at $360 - $1764 per kg (Kadlec and Knight, 1996; AECOM, 2011). Replacement costs of both constructed wetlands and conventional water treatment systems were estimated as a comparison to wetland restoration cost. Annual values were also estimated assuming historic wetland loss rate of 0.6%. The cost of constructing wetlands to provide the same amount of water purification services supplied by natural wetlands was estimated to range from about $71 million to $347 million for the study area. This corresponds to an estimated $0.4 million to $2 million per year in economic value losses under historic loss rate. Conventional water treatment facilities would necessitate about $140 million to $650 million in costs. This corresponds to an estimated $0.8 million to $4 million.

4. Carbon storage

The economic value of carbon storage in the study area was estimated by multiplying the stock of carbon stored in the case study area with different values of carbon supplied by the Canadian Council of Parks, generated using different methods for economic valuation.

The value estimates of carbon stored in wetlands vary considerably, with a range from a low of $608,552 to a high of $299 million, depending which valuation method is conducted. With the $15/tonne of CO2eq in Alberta context, this amounted to $16.7 million for the study area. By applying a SOC loss of 89 Mg ha-1 as the amount of carbon re-emitted back to the atmosphere due to wetland drainage, the value of the SOC loss would range from $264,152 - $130 million.

Given the $15 per tonne of CO_2eq the loss of value becomes $7.3 million if all wetlands were drained; the annual value loss became $44,000, at 0.6% of annual wetland loss rate.

5. Other Ecosystem Services

A literature review was conducted to determine known links between all other ES assessed in wetlands and human well-being (crops/food, pollination, *soil formation, erosion control and sediment retention, science & education, tourism, heritage values, aesthetic benefits*. Additional information was developed for the following ES through economic valuation and socio-cultural survey:

6. Crops/food

The average density of cattle was calculated for the study area. The total water requirement for cattle was estimated, as well as the total water capacity of wetlands in the study area. It is unknown what proportion of cattle water requirements is met by wetlands vs. other sources (groundwater, streams).

7. Cultural ES

A values survey was conducted to determine people's conceptions about the value of ES from wetlands. Qualitative responses included expressed opinions about wetlands and the ES they produce:

> "*Wetlands are sacred places*"
>
> *"Wetlands give us a sense of peace and well-being"*
>
> *"It is important to maintain wetlands for future generations."*

The pilot also completed an economic valuation study of bird watching in the study area. The economic valuation study estimated the number of people partaking in wetland recreation trips for birding and the recreation value of specific wetlands associated with Ralph Klein Park (RKP) for birding. Data was collected from on-site surveys of visitors to RKP and Inglewood Bird Sanctuary (IBS) to input into two economic models – Gravity Model and Travel Cost Model (please see Economic Technical report for more detail). The Gravity Model (Saunders *et al*., 1981) was used to estimate the potential number of birding participants from the City of Calgary and the Travel Cost Model is an established stated preference value estimation method used widely in recreation value studies (Ward and Beal, 2000). The annual value of recreation was estimated to be about $4.4 million based on an estimate of 114,685 participants each year and per person daily value of about $38. Most of the recreation value was associated with bird watching and outdoor recreation in signature sites in the Shepard Slough (e.g. Ralph Klein Park).

An economic analysis of the perceived value of wetlands to education and science focused on Ralph Klein Park (RKP). The school visits data provided by the City of Calgary indicate that in the school year of 2011- 2012, 19 schools scheduled visits to RKP (McColl, 2011). An estimated 10,550 students are expected to visit the park in 2012 to participate in education programs (RKP Staff, 2011). The distances traveled from schools to the Park (straight-line distance on the map) range from 5,046 meters to 26,635 meters with an average of 17,077 meters. Most of the schools are located in the City of Calgary but there is also one from DeWinton and one from Town of Chestermere.

The pilot project specifically examined one aspect of an aesthetic service, the amenity value of wetlands associated with housing prices. Urban developments are increasingly incorporating wetland features into their landscape planning for two main reasons - amenity and aesthetics, and stormwater management. The ES Pilot used a hedonic pricing analysis to determine how housing prices are affected by proximity to wetlands. Hedonic pricing analysis uses housing prices and distances to wetlands to determine the economic benefits from wetland proximity. Two residential developments were chosen for this assessment: McKenzie Towne and Copperfield, located in the southeast urban fringes of Calgary.

Two components, the value of adjacency (located next to a wetland) and the value of proximity (distance from the wetland) were assessed for two communities located in/around the case study area to examine the effect on aggregate house value. Adjacency to wetland was estimated to increase house value by $4,390 (1.14% of house value) in Copperfield and $5,136 (1.3% of house value) in McKenzie Towne. Aggregating this value across all the adjacent properties yielded value that ranged from $0.3 million to $0.8 million. The value of proximity was estimated to be $16.7 million for McKenzie Towne. Similar calculation was not performed for Copperfield due to model limitations.

Future work on the links between ecosystem services and human well-being
The ES Pilot investigated the links between ES and human well-being using scientific literature, a socio-cultural survey, a stakeholder workshop, and economic valuation studies. This work was constrained by the time limitations of the ES Pilot, as well as by a lack of data and expertise for conducting the work. Linking ES to human well-being is not straightforward and also requires a biophysical assessment of where on a landscape ES changes might impact human well-being. For example, an assessment of flood control should include an assessment of where flood risk is the greatest for humans. Some of the types of questions that it would be useful to address in future work include:

- Where are the risks to humans associated with the loss of ES?
- What are the areas that are particularly important for the provision of ES and therefore particularly valuable to humans?
- What are the impacts of development activities on ES?
- What trade-offs are occurring between ES provision and development or between multiple ES?
- Who is benefiting from changes in ES and who is losing from this?
- How does the provision of multiple ES occur, and how are people benefitting from multiple ES provided by wetlands?

Step 5: Identify ecosystem service risks and opportunities for management

This step called for the integration of the information on condition and trends in ES, impacts to benefits to human well-being (both economic and socio-cultural), and future projections of trends, and identify management risks and opportunities related to ES.

Critical Lessons Learned

- Risks and opportunities refer to the outcomes of decisions that do or do not consider ES. For example, what are the risks of allowing subdivision development to occur as it has in the past without considering the importance of wetlands for flood control, water purification and aesthetic benefits? And what are the opportunities for developers and decision-makers associated with management choices that promote wetlands and their multiple ES amidst development?
- This step is key to answering a key 'so what?' question for management of ES to decision-makers and developers. If the assessment results can communicate real risks to development success or to people from ignoring ES, or real benefits that may emerge from the enhancement or maintenance of ES for developers and communities, management of these ES may become a focus of decision-makers.
- Important to ensure that there is a common understanding of risk and that the risks and opportunities are relevant to the decision-makers.
- Possibilities of risks and opportunities could be discussed with decision-makers at the beginning of the process to identify the kinds of risks and opportunities that seem most relevant to them.
- Decide at what point Step 5 will be developed as the ES Approach is to be an iterative process, not linear.

The original planning team (spring/ summer 2010) was uncertain about how to formally integrate Step 5 into the pilot work plan. It was felt that the Core Team and sub-team members would be able to assess the limitations and opportunities for this step once Step 1 was completed and the case study area and approvals process was understood. The idea was that it was necessary to see what the focus of the ES assessments would be and what would come out of the earlier steps to determine the breath and scope of this step. As originally intended there was to have been more teamwork across steps and assessment sub-teams which would have more naturally lead to this step being incorporated; however that was not the case.

About a quarter of the way into the ES pilot, the Core Team was tasked with assessing Steps 5 and 6 and tasked with coming up with a plan to deal with both of these steps. At the inception of the ES Pilot, there were no teams set-up to deal with these pieces as it was assumed there would be an integrated approach delivered by the appropriate group and signed off by the Steering Committee. At the same time that Core Team began to discuss how to frame these two pieces the team began to focus on issues around integration, as the ideal to be integrated throughout the ES Approach steps fell down due to lack of resources and time coupled with more uncertainty and work required to do Steps 2 through 4.

The Core Team explored different ways of looking at risks and opportunities. The focus for Step 5 on the risks and opportunities to ES from the wetland approvals was to develop sub divisions in our case study areas. There was a local focus based on where development is headed and a larger scale case study focus. On the risk side, GoA had incorporated the use of the ISO risk management framework. In addition, the 'Bow Tie' method of rapid risk assessment was reviewed. There was need to establish what risk to what as there are different scales and understandings of risk.

The Core Team discussed the use of Scenario planning to investigate risks and opportunities, but instead decided to use stories and build on identified trends in the case area to present decision makers with information for their use in the wetland approvals context. However, this task was not initiated due to time limitations. Different approaches to assessing risks and opportunities around ES were discussed throughout the process. The GoA committed to a specific ISO risk management approach. In addition, ESRD has been working on a Bow Tie risk model that was supported by the executive. The pilot team met with the Risk Management Branch on a number of occasions to see how the pilot could use the tools currently in operation within the department.

Step 6: Input ecosystem service information into decision-making

Ensuring that ES information is produced in a meaningful way to be of use to decision-makers, this could include the development of specialized reports, figures, tables and maps to communicate relevant findings to specific decision-makers and stakeholders.

Critical Lessons Learned

- Steps 1, done properly, allows for Step 6 to have sufficient focus.
- Having access to the key decision-makers throughout the process allowed for timely and informative feedback to ensure that results and information is useful.
- Understanding the bounds and capacity of the inputs you can provide, such as hot spots maps.
- Providing credible and relevant information through a legitimate process.

Step 6 was considered heavily at the design of the pilot. In the beginning staged of the pilot it was important to have the decision-makers input and buy-in on Step 1 in framing the issue as, once framed, that issue helped the ES team and the decision-makers to stay focused on what was needed and where the end points were for the assessment information and sub-team work.

As with many work plans Step 6 was considered the endpoint to which the rest of the steps and processes needed to build toward. This was important as it kept the team focused on producing something of value and use to the decision-makers. It was decided to ensure that there was access to the key decision-makers, also our key stakeholders for the ES Pilot information, by having them within the team and by also requesting sessions with them together and one-on-one as time permitted to vet ideas and draft results to ensure that the team was on the right path to producing useful and relevant information.

The steering committee, on which the decision makers sat, met monthly and was another opportunity to vet the work and processes the Core Team and sub-teams were undertaking and the projected results from the work. Meetings with the decision makers were less frequent and on a need to have input bases. We met with the three pilot decision makers (City of Calgary, Rocky View County and Wetland Approval staff at ESRD) four times and had individual discussions with some of them more frequently. At the beginning, the ESRD decision-maker was on the weekly Core Team meetings but that become inefficient given our access to him at Steering Committee and individually and given the detail of work discussed at Core Team.

In interaction with the decision-makers a number of ideas and potential tools were presented to help them frame what would be useful and in what format. This helps to spur on creativity on what we could do with the ES assessment information; however there was not adequate time or capacity at the end to translate the ES assessment information into all the products that might have been useful to the decision-makers. The decision-makers were pleased with the information and products that were created but there was room for more to have been done. Additionally, the hurried nature of completed the three assessments meant that some of the results were not as credible or as deeply developed as they could have been, this would have enhanced the usefulness and relevance of the results.

Policy relevance was one of the three principles of the pilot and was considered top of mind given the objectives of the pilot. If the decision-makers did not find the process and/ or the products and results useful, it would have been a significant hit to the future support and consideration of the ES Program work and employing another ES Approach.

3. Organization of the ES Assessment

Section 2 outlined the steps and activities undertaken to provide complete assessment results for the ES Pilot. However, some of the biggest challenges lay in the organization of the assessment. This section discusses some of the organizational steps and activities that were implemented during the ES assessment process, emphasizing challenges and potential solutions to those challenges for future ES work.

It is important to note that not only was the ES Core Team tasked with developing information about ES from wetlands in the study area, they also had a number of other objectives outlined by longer-term objectives in the ESRD ES Road Map, including:

- Lead the promotion and recognition of ES as an approach to decision-making within ESRD;
- Assess data and information needs required for quantitative measurement of ES to support the approach;
- Assemble a team[5], with expertise and members from inside and outside ESRD, to help build capacity and leverage the current quantitative ES data and information available;
- Assess current data and information[6] available for quantitative measurement of ES;
- Determine the appropriate types of tools that are required in order to communicate quantitative measurement within the approach (e.g. maps);
- Integrate data and information into the approach;
- Monitor performance of the approach; and
- Apply continuous improvement of the application of the ES approach and tools.

The assessment process thus had to be organized in such a way as to accomplish as many of these additional objectives as possible.

3.1 Assessment Team and Leadership

Critical Lessons Learned

- Due to the complex nature of assembling multi-disciplinary information about ES that answers specific questions from decision-makers, a full-time project director is necessary to organize and follow the work of the team, and plan the integration of information across disciplines. Additionally, a project manager may be necessary depending on the scope of the project to allow the project director to focus on substantive issues.
- The choice of assessment team members should be based on their expertise, and occur after choosing the ES that will be the focus of the assessment. This is because relevant expertise for answering questions about specific ES is required. e.g. if ES related to water are the focus of assessment, a hydrologist is needed to lead the assessment of those ES.
- Assessment sub-teams can be divided along disciplinary lines to develop some methods (e.g. an economic sub-team and a biophysical sub-team); however, multi-disciplinary teams

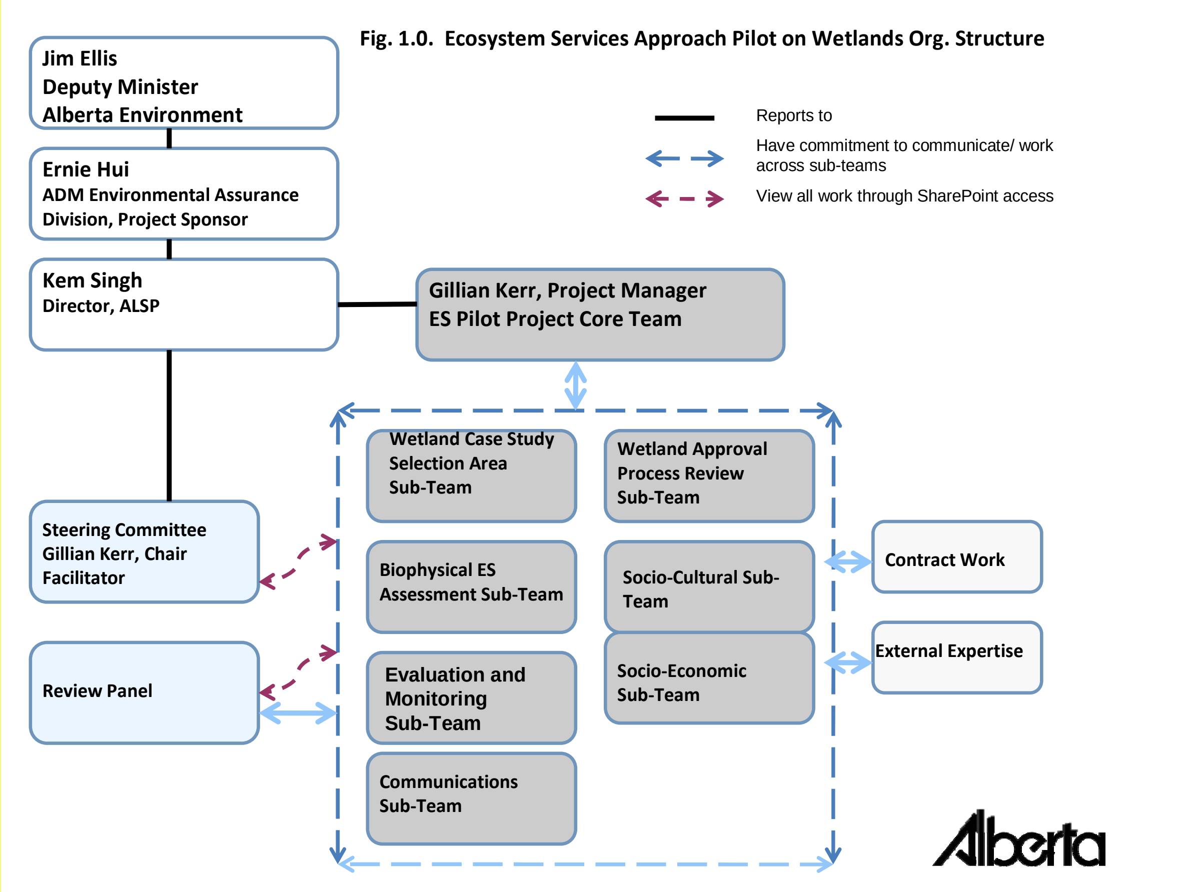
[5] Consider updating Alberta Environment's EGS Phase 1 Report, Key Actors and Initiatives March 2007 to identify work that has been or is currently being done on EGS in the Province
[6] Consider reviewing all of the ES information created for Alberta Environment's identify work that could contribute to quantitative measurement of ES

built around the assessment of individual ES could provide a good platform for developing complex, multi-disciplinary information necessary for answering questions about ES.

- A GIS expert is needed to build a database, perform analyses and interpret spatial information, as most available ES data is spatial.

Figure 7 presents the organizational structure of the ES Pilot, which included biophysical, economic, and socio-cultural sub-teams that were responsible for producing the content for assessment reports, evaluation and communication teams that evaluated the process and communicated results, and a Review Panel and Steering Committee. The Steering Committee was established to ensure project outcomes were accomplished, and to provide guidance and oversight to the process and deliverables. The Steering Committee was composed of target decision-makers and other stakeholders representing government, non-profit and academic communities. The Review Panel was established to contribute to the delivery of the ES Approach, provide contextual information about Alberta and ES, and enhance project credibility by reviewing deliverables.

Figure 7. Organizational structure of the ES Pilot



3.1.1 Core Team organization

It was decided by ES Pilot team members that the Core Team would comprise ESRD employees that would lead the work of the various sub-teams and provide key connections and advice to target areas for the pilot including CEMS, Regional Planning, GIS, what was previously the

Integrated Monitoring Environmental Reporting Framework, and across Divisions to ensure support for and understanding of the pilot. The CORE TEAM, therefore, needed to have a broad level of the skill sets that were required for the ES Pilot so that the team could act as guides for sub-team work and could understand enough to ask the right questions and know when other resources were needed. The skills on the team, set out by the four original members in the initial design, were to contain: GIS, economics, biophysical (ecology, biology), social science, ESRD ES program expertise, evaluation, communication, education and outreach, administrative support, and project management.

The key purpose of the Core Team was to provide an integration point for all of the ES Approach work. Committee member responsibilities included:

- Leading the sub-teams
- Ensuring the ES Approach steps were undertaken collaboratively
- Working on all Core Team activities and reporting back to Core Team
- Contributing knowledge to the approach and assessments
- Finding experts and research to support information needs about ecological, social or economic systems
- Developing and reviewing draft and final materials and major deliverables
- Ensuring that the project is credible, legitimate and relevant to the decision makers needs

The Core Team comprised 10 people initially, but 5 people were lost during the process. This was an important challenge, as the learning curve for understanding ES is steep, and much energy was expended in building capacity in new team members. Non-Alberta ESRD members were added due to resource constraints and the lack of specific skills sets.

A project manager (PM) with deep understanding of the ES concept led the assessment process. Because ES science is relatively new and few people have experience in this kind of work, it was very important to have this type of manager. However, it became clear that a relatively greater amount of problem-solving and mentoring was necessary throughout the project to lead the team through the complex assessment process, and the project manager did not have enough hours to devote to the intense organizational, substantive and communication tasks required. The assessment would have been better served if the project manager could have focused expertise on the organization and development of the substantive portion of the assessment, and an additional person could have taken care of project management issues. The time needed throughout the entire assessment process for brainstorming and decision-making by a person with good knowledge of ES theory, the ESRD context, and the assessment organization, was underestimated. In the case of the ES Pilot, this was an unavoidable constraint; however, future assessment work might take into account the importance of adequate time investment for leading ES work and attempt to reduce the non-substantive work of the project manager.

3.1.2 Sub-team organization

It was recognized by the Core Team that a larger team, a Steering Committee and Review Panel would be needed to guide and undertake the work. To ensure that each team had a clear mandate, roles and responsibilities, Terms of Reference (ToRs) were developed for each using a consistent template. ToRs were developed for each of the following sub-teams: Approvals Process, Case Study Selection, Biophysical, Socio-economic, Communication and Education (modified to just Communications later in pilot), Evaluation and Monitoring (Modified to just Evaluation later in pilot) and Socio-cultural. Due to the fact that the Government of Alberta was under a hiring freeze and that team members were needed from across the Government, it was critical to be as clear as possible on the roles, responsibilities and expected outputs from each team and to get the support and signatures from all supervisors.

The assessment sub-teams were assembled based on required expertise. The project manager understood the need for expertise from different disciplines and secured the participation of economists, biologists, GIS specialists, evaluation, social science, policy analysts, ecologist, wetland policy members, and communication specialists. A major challenge, however, was securing enough time from team members on a weekly basis, and keeping team members for the duration of the assessment. In the end, there were no biophysical scientists leading any of the teams, which was a serious deficiency and led to a lack of capacity to complete the biophysical assessment of ES. In addition, this lack of biophysical expertise made it difficult for the other sub-teams to interact and plan with the biophysical team in a timely manner, as the biophysical team failed to progress as expected. The biophysical team, instead, became more of an overall assessment management unit, helping to organize assessment work, write assessment reports and interact with external consultants. However, this only highlighted the need for more overall project management time/personnel, and left a gap in the biophysical component of the assessment. This gap was eventually filled by external consultants towards the end of the project, but it meant that for the majority of the assessment there was a lack of adequate planning around the development of detailed methods required to best answer the questions of decision-makers.

While team members with diverse expertise were assembled, a more strategic choice of team members might be to bring in individuals with expertise on specific ES. This would require choosing the ES for assessment before assembling assessment teams, but would ensure that the requisite experts would be involved. This is particularly important for biophysical scientists, who are often highly specialized. The biophysical team assembled a group of biological scientists to work on the assessment, but as they didn't have the specific expertise related to the ES that were eventually chosen as the focus of assessment, they did not end up contributing much to the assessment work.

The assessment sub-teams were formed along disciplinary lines. While this worked well in some teams for the development of some information (e.g. the economic team that had the requisite expertise and experience), this structure did not lead easily to the type of integration of different knowledge that is necessary for developing useful ES information. Guidance on how to organize teams and disciplines to complete ES work is lacking in the literature, and there is no clear 'best' or even 'better' way to do this. One suggestion that emerges from the ES Pilot experience is to have teams organized according to disciplines, but then cross-appoint individuals from each discipline to special ES teams. For example, a climate scientist, economist and ecologist could work together on the assessment of micro-climate regulation. In this manner experts with similar expertise could work together to develop the best methods for completing certain tasks within their discipline (e.g. economists could brainstorm on best ways to perform a travel cost analysis), but experts could also work across disciplines to develop a complete method for answering questions from decision-makers that require complex information developed and integrated from multiple disciplines (e.g. what are the ecological and economic implications of removing a particular wetland that is valuable for flood control?).

3.1.3 Roles of all Assessment teams

The key purpose of the Steering Committee was to ensure that the project outcome was accomplished and to provide oversight to project process and deliverables to that end. Committee member responsibilities included:

- Providing guidance and advice to key stages of project set up, approach and delivery
- Confirming the need for the ecosystem services approach
- Confirming key questions framing the approach
- Contributing knowledge to the approach and assessments
- Contributing information and advice about ecological, social or economic systems from their area of expertise
- Approval of the project plan, including milestones and deliverables
- Reviewing and approving of draft and final materials and major deliverables
- Ensuring that the project is credible, legitimate and relevant to the decision makers needs

The purpose of the Review Panel was to review key documents and to sit on sub-team committees. Responsibilities included:

- Participate on sub task teams based on expertise if required
- Review and provide comments on draft and final materials and major deliverables
- Use your involvement in the review panel to update or inform relevant working groups where possible
- Contribute knowledge to the approach and assessments
- Contribute contextual information about ecological, social or economic systems
- Ensuring that the project is credible, legitimate and relevant to the decision makers needs

The primary purpose of the Case Study Selection Area Sub-Team was to select the case study area for the ES Approach Pilot project. Responsibilities included:

- Develop criteria to select a case study area.
- Development potential locations that meet criteria.
- Document the case study selection process components.
- Work with other interest groups or individuals as needed.
- Draft and finalize report that outlines the case study selection process.
- Ensure all activities and deliverables are credible and legitimate.

The primary purpose of the Wetland Approval Process Review Sub-team was to review the approval decision-making process for wetlands in Alberta and do a gap assessment of the process. Responsibilities included:

- Provide advice and contribute knowledge and experience to the review process.
- Ensure communication with other sub-teams, steering committee and review panel are conducted in accordance with the objective of the pilot project.
- Review and outline the current approval process of wetlands in the province.
- Document the approval process components.
- The sub-team will consider and make recommendations on the gaps of the current approval process.
- Work with other interest groups or individuals as needed.
- Draft and write the final report that outline the approval process and identify gaps; which is the main deliverable of the sub-team.
- Ensure that all activities and deliverables are credible and legitimate.

The purpose of the Communications and Education sub-team was to develop, disseminate and implement information and resources related to the ES Approach and outcomes. Responsibilities included:

- Develop a communications strategy for the ES Approach Pilot for GoA and external audiences.
- Work collaboratively with the other sub-teams.
- Present key issues and decision points to the Steering Committee
- Deliver on Integrated Work plan activities
- Ensure that all activities and deliverables are credible and legitimate and promotes transparency.

The purpose of the Evaluation Sub-Team was to evaluate achievement of project objectives and capture lessons learned throughout the project.

Responsibilities included**:**

- Work with members of the core team to evaluate achievement of project objectives in a valid, reliable, transparent, respectful, and timely way, including the development of necessary process and tools as required.
- Coordinate the development of performance measures/indicators for each project objective, using the work break down structure, project plan, and charter as a guide.
- Develop process and tools to ensure that lessons learned during the project are captured and available to inform future ES Approach work and future capacity building.
- Collate the steps taken, and lessons learned along the way, within the project to operationalize ES within the wetlands approval context.
- Adhere to project team organizational and governance structure.
- Contribute to, discuss, review, and draft the final evaluation and lesson learned deliverables.
- Present key issues and decision points to the Steering Committee.

The key purpose of the Biophysical sub-team was to deliver the biophysical assessments and to ensure that both Steps 2 and 3 of the ES Approach were carried out. The original intent was that they would lead an interdisciplinary and inter-Core Team process, similar to the Socio-econ and Cultural teams leadings Step 4 and part of 2; however due to time and resource constraints and the number of surprises and uncertainties, the team were originally left to carry them out more in isolation and to bring them back to the Core Team. Each team was mandated to collaborate and ask for help when needed. Biophysical responsibilities included:

- Develop a valid, reliable, transparent, respectful and timely process for delivering on Steps 2 and 4 of the ES Approach.
- Work collaboratively with the socio-cultural and economics sub-team to ensure the integration and acknowledgement of different perspectives where appropriate.
- Explore the key methodologies that can be used to deliver on biophysical deliverables.
- Contribute to, discuss and review process and drafts and write the final deliverables.
- Present key issues and decision points to the Steering Committee.
- Ensure the sub-team project is completed on time and within scope.
- Providing guidance and advice to key stages of project set up, approach and delivery.
- Ensure that all activities and deliverables are credible and legitimate.

The two keys purposes of the Socio-cultural and Socio-economics Sub-teams were:

1) The Socio-cultural and socio-economics sub-team will work collaboratively to produce a coherent process to deliver on part of Steps 3 and all of 4 of the ES Approach and 2) will contribute to the Biophysical sub-team process and deliverables on Steps 2 and 3.

Responsibilities included:

- Develop a valid, reliable, transparent, respectful and timely process for delivering on part of Steps 3 and all of 4 of the ES Approach.
- Work collaboratively with the Biophysical sub-team to ensure the integration and acknowledgement of different perspectives where appropriate.
- Explore the key methodologies that can be used to deliver on socio-cultural and socio-economic deliverables.
- Contribute to, discuss and review process and drafts and write the final deliverables.
- Present key issues and decision points to the Steering Committee.
- Providing guidance and advice to key stages of project set up, approach and delivery.
- Ensure that all activities and deliverables are credible and legitimate.

3.2 Work Organization

Critical Lessons Learned

- There are no straightforward guidelines available on how to organize multi-disciplinary work on multiple ES; therefore careful planning on how work is distributed among individuals and teams is required in order to develop information that directly answers to the needs of decision-makers.
- Choosing the ES that will be the focus of assessment is a critical first step and should be completed before other work is started.
- Deciding on specific and detailed questions that will be answered by the assessment also needs to be completed before assessment work begins. Questions should be developed by multi-disciplinary teams assigned to each ES, in collaboration with decision-makers.
- Multi-disciplinary teams, working together, are best suited to developing a plan for how to assess each ES. For example, a hydrologist and economist will come up with the most suitable and complementary methods for answering specific questions about flood control than would each of these experts working alone. This process will also identify limitations in knowledge, data and methods that will help determine the most strategic way forward for different members of the team.
- Assigning specific tasks to individuals early in the assessment process will allow them enough time to research appropriate methods, understand data availability, interact with other team members and take ownership of assessment results.
- All team members should have a clear idea of the final products being developed and work towards contributing to those products. The main product of an ES assessment will usually be a report that integrates all information developed by different teams and individuals to respond to the specific needs of decision-makers.
- Decisiveness from project leaders (including the Steering Committee) is needed to promptly balance time allocated to discussions, theoretical issues, and stakeholder participation, with achieving progress and organizing the work within project timelines.

The organization of the assessment work steps are described in detail in Section 2 of the report; here we report on more general organizational issues related to developing an ES assessment and on the most important lessons learned. Organizing the assessment work was the biggest challenge of the ES Pilot. Neither WRI 2008 nor Ash et al. 2010 provided clear guidance on how to organize work that was multi-disciplinary and that involved the assessment of multiple, interacting ES. A learning from the Results report is that no such detailed step-by-step guidelines on how to do this work is possible as ES assessments are place-based and context specific.

The original intent for organizing the work was that the Core Team would work together to complete all the steps in the ES Approach, both working across disciplines to complete some tasks and within their sub-teams on other tasks. With extreme resource losses at critical times and the need to hire consultants to do the work intended for GoA staff, coupled with clear capacity constraints and steep learning curves, the Core Team needed to divide up the work.

The ES Pilot experienced a challenge that is idiosyncratic to large organizations or government. Many different individuals were partially involved in the ES Pilot, with varying numbers of hours per week dedicated to the assessment work. The ES Pilot found it challenging to work with so many people with little ES expertise and few assigned hours because it was not clear how to best make use of their expertise. Many individuals participated in regular meetings where much discussion took place and few concrete tasks were assigned. Individual were then asked towards the end of the process to contribute in small ways, but many did not at that point have the time to commit further, or did not have the expertise to enable them to volunteer. To best make use of this type of work commitment in the future, assigning specific tasks to individuals early in the assessment process would allow them enough time to research appropriate methods, understand the process better, understand data availability, interact with other team members and take ownership of a part of the assessment results.

Once the approach steps were divided amongst sub-teams, it was not obvious how the teams and individuals involved in the ES Pilot should work together to address assessment questions. The project manager addressed this issue by spending a lot of team at the start of the process familiarizing team members with the ES concept, previous assessments, ES literature and assessment methods. However, it became obvious once the principal work of the assessment was initiated that the details of how to work together to develop information on individual ES were unclear. The organization of the ES Pilot assessment work was thus highly experimental, with the expected result of learning a lot about ES assessment organization throughout the process and through an evaluation of the process after the fact.

The sub-teams that were organized along disciplinary lines were given responsibility for completing different steps in the chosen ES Approach. For example, the biophysical sub-team was given responsibility for the completion of Steps 2 and 3, while the economic and socio-cultural sub-teams were responsible for completing Steps 4 and 5. It was expected that the sub-teams would work together to some extent on all of the steps, however, the division of responsibilities for each step, the division of disciplines across the sub-teams, and the geographic separation of the teams that were based either in Calgary or Edmonton contributed to the artificial isolation of the sub-teams from each other. The sub-teams interacted less than expected, and the integration of methods and findings from the different teams was therefore a great challenge. Because information from different disciplines was needed to complete each of the steps in the assessment approach, it was not possible for individual sub-teams to complete any of the steps themselves, creating some confusion and a lot of discussion at team meetings about how to complete each step.

The ES Pilot experience was to have the different sub-teams work on each ES in isolation. The very nature of questions about ES, which try to link ES to human well-being, the economy and development choices, requires a concerted effort between disciplines to decide how to answer these questions best. The difficulty experienced by the ES Pilot teams in coming up with appropriate questions, and then methods to answer the questions suggests that multi-disciplinary teams, working together, are best suited to developing a plan for how to assess each ES. For example, a hydrologist and economist will come up with the most suitable and complementary methods for answering specific questions about flood control and its relation to development than would each of these experts working alone. This process will also identify limitations in knowledge, data and methods that will help determine the most strategic way forward for different members of the team.

Each sub-team was expected to produce its own report from a methodological basis. One outcome of this was that sub-teams focused more on the writing of their own reports than on contributing to an integrated report that would be presented to decision-makers. A strategy for getting teams to focus on answering the same questions for decision-makers would be to focus everyone's energy on producing one integrated report, and having the sub-team reports as secondary objectives.

A major challenge of all ES work as promoted by WRI 2008 and Ash et al. 2010, is balancing the need to make quick decisions and progress with the assessment, and achieving credibility, legitimacy and relevance in the process – key principles of the ES Approach. For example, the ES Pilot team struggled with choosing the ES that would be the focus of the assessment, as the goal was to choose the ES with as much input from stakeholders, decision-makers and scientists as possible. However, finalizing the choice of ES to include in the assessment was key to determining what experts were needed to conduct the assessment and how to organize multi-disciplinary teams to work on the assessment of individual ES, and therefore needed to be completed quickly. The ES Pilot erred on the side of promoting discussion and participation in project decisions, resulting in slow progress in the assessment and a lack of structure for the multi-disciplinary assessment of individual ES. A lesson learned from this experience is that strong and prompt decisions from project leaders (including the Steering Committee) are needed to balance concerns about stakeholder participation with achieving progress and organizing the work appropriately. We suggest that the choice of ES to focus an assessment is a key project organization step, and must be completed in a timely manner, with appropriate input from stakeholders, before the assessment work can be further organized.

Another challenge faced by the ES Pilot was determining what information needed to be developed by the assessment teams. A major success of the ES Pilot was working with decision-makers to identify a specific policy process that could be informed by ES information. The ES Pilot went further than most ES assessments in assessing policy gaps to be filled by ES information, in this case related residential subdivision development and the wetland approvals process. Once this step was completed, however, there was less discussion of the specific information about individual ES that could best inform the policy process. One reason for this is the relative newness of the ES concept. To a degree, decision-makers were simply interested in learning about ES and what ES were relevant to their decisions. This goal was met successfully by the ES Pilot. The development of more focused information about ES related to wetland approvals decisions was less successful because it was difficult to decide upon the specific questions to be answered. These questions should be decided at the beginning of the assessment with the input of decision-makers, and experts from multiple disciplines. The simplest way to organize this process is to ask small teams with different disciplinary expertise to work with decision-makers to develop detailed questions about individual ES. Trying to develop questions for all ES at the same type may be overwhelming and confusing, as each ES is produced and consumed in vastly different ways. Detailed questions, such as 'which parts of the case study area are most at risk from flooding?' are preferable to vague questions, such as 'how much flood control is there in the case study area?' Once the focus ES are chosen and specific questions are developed in relation to ES condition and trends, risks and opportunities, additional subject matter experts can be brought into the assessment teams to fill gaps in expertise.

During the ES Pilot several different methods were considered to ensure that there was a central repository for work plans and deliverables. In the end a document called the Integrated Work Plan (IWP) provided an oversight area for the work of all the sub-teams and how it was intended to be integrated into meeting the objectives and overall deliverables of the pilot. The IWP main sheet was the key tool of the project manager to ensure that activities, resources and timelines were being used appropriately. The sub-team leads were committed to use the IWP to identify potential points of integration and to report on work progress using a traffic light approach (e.g. red means behind schedule).

Table 7 provides a snapshot of some of the key tasks

Task No.	**Description**	**Lead**
4.10	Complete draft Biophysical Assessment Report, validate with Steering Committee and finalize deliverable.	Biophysical Team
4.11	Complete draft Education Report, validate with Steering Committee and finalize deliverable.	Communications Team
4.12	Develop 'Executive Brief' package for Alberta Environment and Sustainable Resource Development, GoA Executive and Non-GoA including 3-4 page project overview, PowerPoint presentation deck with speaking points, and other materials as identified in the Communications Plan.	Communications Team
4.13	Complete the draft Socio-Cultural Valuation report, validate with Steering Committee and finalize deliverable.	Socio-Cultural Team
4.14	Complete the draft Socio-Economic Valuation report, validate with Steering Committee and finalize deliverable.	Socio-Economic Team
4.15	Prepare draft evaluation report	Evaluation Team
4.16	Finalize evaluation report	Evaluation Team
4.17	Prepare other evaluation/lessons learned outputs as time permits	Evaluation Team
4.18	Analyze WESPUS results	Biophysical Team
4.19	Review and analyze quantitative assessment results	Biophysical Team
4.20	Develop WESPUS content for the technical report	Biophysical Team
4.21	Conduct technical report planning sessions (July 27-28) ** Plan to complete will be developed as the output from these sessions	Biophysical Team
4.22	Complete the draft decision makers report, validate with decision makers and finalize deliverable.	Communication and Education
5.10	Develop communications plan	Communications Team
5.11	Develop presentation decks for specific audiences (comm. team / no budget)	Communications Team
5.12	Ensure we highlight connections to other policy opportunities in GOS.	Communications Team
5.13	Opportunity to connect with staff training (CEMS)	Communications Team
5.14	Brief GoA executives (Gillian)	Communications Team
5.15	Presentation Schedule	Communications Team
5.16	Explore internship and project position	PMO
5.17	Tie ES Pilot to Strategic CEMS/ LUF priorities (e.g. Land-Use plans)	PMO

3.3 Communication within the ES Pilot Team

Critical Lessons Learned

- Due to the complexity and breadth of information required to understand ES and their contribution to human well-being, communication across the assessment team is crucial to avoid duplication of efforts and to allow for synergistic learning about ES.
- Regular face-to-face team meetings greatly enhance the ability of the team to work together on developing appropriate and complementary methods, and integrating assessment results.
- The use of conference calls and sub-team meetings can be useful as long as there is a specific objective and outcome associated with each call or meeting.
- The use of Sharepoint and other tools such as WebEx can be useful if time is taken to organize them to fit the project, if rules are established for their use, and if they are in functioning order.
- Because of the iterative nature of ES assessments, and because the relatively new field of ES science is still developing, new information and methods may be introduced regularly throughout an assessment process. Leadership is crucial in determining whether discussion of new methods within and across teams is desirable or whether progress is more important – this will depend to a degree on the stage of the process.

The ES Pilot put in place several mechanisms to encourage sharing of knowledge across assessment sub-teams. A regular conference call of core team members from each sub-team was set up and continued throughout the entire ES Pilot process. There were several face-to-face meetings of the core team as well, but perhaps not enough to determine how the different disciplinary teams might work together effectively. In addition, perhaps because other mechanisms for developing information in a multi-disciplinary manner were not put in place (such as multi-disciplinary teams built around individual ES), there was often not much overlap in what the sub-teams were doing, and therefore communication across sub-teams was often unfocused or unproductive. One result of not having collaborative work to discuss across teams was that discussions were often focused on theoretical issues that were frequently revisited and led to more questions than answers and some frustration. However, the general goal of meeting regularly to share knowledge is an important one, and was well-recognized by the ES Pilot team.

Because of the iterative nature of ES assessments, and because the relatively new field of ES science is still developing, a chain of command for decision-making and finalizing process steps was crucial. Sub-teams and individuals were working separately on different components of the assessment, reading different theoretical material and coming up with different ideas and approaches. Ecosystem service work is particularly challenging because it involves assigning societal values to components of ecosystems, and there is no clear way in which to do this. Because there was an understanding within the ES Pilot team that a common approach was to be used and that findings should be integrated, many questions arose throughout the process about terms, methods and theory. Decision-making and communication among team members is key to keeping the process on track.

3.4 Interacting with Assessment Users

One of the key successes of this ES pilot was the interaction with the assessment users. At the outset of the pilot a great deal of time and strategising went into who the key players were to be for the ES Pilot and what the scope of assessment users could and should be given the context and nature of the focus on the current wetland approvals process for residential sub-divisions in the study area.

Critical Lessons Learned

- The ES Pilot was successful and pioneering in how the assessment process was designed to meet the needs of specific decision-makers related to a particular policy process. This same level of attention to the identification and analysis of information gaps related to a precise policy issue should be replicated in future ES work, and involves building strong relationships and communication with assessment users.
- Communication tools, such as Assistant Deputy Minister and Steering Committee-approved key messages and a two-pager on the pilot provided simple and brief communication tools to build common understanding of the pilot and its purpose across ES team audiences, government and others interested in the work. These tools also provided an entry point for those not involved in the pilot to ask questions and learn more about the work.
- Strong support from project champions carried the pilot to completion, particularly when there were challenges.
- Having key decision-makers/stakeholders involved in the pilot design and implementation was critical to success and achieving legitimacy and relevance.
- Having trusted critics to scrutinize work before it is distributed can help to catch problems early.
- Investing time at the beginning of the process in identifying the people who are key to project success is worthwhile

The ES pilot team recognised there was already a strong relationship with several potential champions within the department, including the wetland approval team in the Calgary office, Assistant Deputy Minister (ADM) and the Director under which the ES program fit. These strong relationships have been forged through the approvals work ESRD had previous to the pilot and the relationship the ES program team had within ESRD based on strong working relationships and trust in the motivation and commitment of the team. It was therefore relatively easy to get an audience with them to build the ES Pilot focus on an issue of relevance to them and to ESRD. These previous relationships were important not only to see the pilot to completion but also to build interest and understanding about what the ES Approach can and cannot do. Other ADMs and Directors recognised the ES pilot as an opportunity to build a new tool to support understanding of cumulative effects, an ESRD priority. These positive relationships were critical to ensuring the ES Pilot was completed, especially given the resource constraints and heavy loss of team members.

To maintain these relationships face to face communication, largely with the Project Manager was employed to ensure the ES team was capturing any concerns or questions and reiterating the objectives of the pilot to maintain the relevance of the work to the champions.

Of note, the PM relied completely on the City of Calgary and RVC team members to maintain the communication within their organisation and this was perhaps too much to ask of the team members and resulting in instances when the organisations involved had doubts about the work or didn't understand that it was going on and what benefit it had to them.

The ADM and Director responsible for the ES Program were direct champions of the pilot in the charter and organisational structure. Reporting to them on a regular basis ensured that the pilot team understood the key issues and concerns of the executive and could work to ensure that the pilot was meeting any relevant needs. This ongoing dialogue was also critical to ensure key communication messages were vetted and approved and new opportunities and risks that arose could be dealt with effectively. It also provided opportunities to look at how and where the ES pilot process and results could benefit other parts of ESRD, garnering more interest and support within the Ministry.

Building a strong foundation within ESRD also provided opportunities to look at where else ES information could provide useful inputs, for example into new regional plans like the North Saskatchewan Region Plan and important assessment work such as the Regional Strategic Assessment. It was noted at the first Steering Committee meeting that this pilot work was useful and important beyond one department and therefore should be framed as a Government of Alberta pilot, as the work was directly useful to the Land-Use Framework, Agriculture and Rural Development, Municipal Affairs, Tourism, and Parks and Recreation. Involvement of Finance and Enterprise in the pilot was useful for other policy and program work they lend their expertise on such as the Land use Framework Strategy 3 on Cumulative Effects Management Strategy. Building a common base of understanding and use for an ES Approach helped to identify future opportunities.

The Steering Committee was purposefully designed to include key ES-related stakeholders and decision-making stakeholders. The Departments selected – Land Use Secretariat and ESRD – were all already active in the study area or in related work on wetlands. Environment Canada, UN-The Economics of Ecosystems and Biodiversity, World Resources Institute, Ducks Unlimited Canada and Alberta Biodiversity Monitoring Institute were all selected due to their significant work either in ES, wetlands, or developing monitoring and assessment tools for wetlands. The City of Calgary, RVC and ESRD wetland approvals decision-makers were included to ensure relevance and a deep understanding of the process to which the ES Approach was being applied. These strategic choices ensured that the Steering committee fulfilling the role outlined in the Terms of Reference (ToR) but also that they provided key connections to relevant work, acting as spokespeople for the pilot and ensuring that any issues, risks or opportunities were identified.

Other representational stakeholders (those that could represent other groups in or around the case study area) were brought onto various pilot teams. For example, Municipal Affairs was a critical team member for the Wetland Approvals sub-team to ensure provincial policy was matched to practices in RVC and Calgary. University of Alberta professors working on a large wetland health project in central Alberta brought critical academic research and scientific influence to the development and work of a number of sub-teams. This also gave the pilot a critical link to the academic world. The need for ES expertise was partially dealt with through long-term relationship with WRI and was enhanced by new relationships with TEEB and the Brandenburg Institute for ES. Developing each new relationship fell to the PM, taking time to build a level of trust, understanding and interest in the work helped to maintain commitment, especially when some team members were attending meetings remotely form the other side of the planet and at non-work hours.

The pilot also benefited from having critique advisors – people that the Project Manager or other team leads could go to, to get a frank and critical reaction to process or product work. This allowed for early signals about things that may not fit or work.

4. How to Operationalize ES Approach in Different Context Within Environment and Sustainable Resource Development

One of the key ideas that generated this pilot was to explore if an ES approach could be useful when applied to a specific issue within ESRD and then to see if the concept and approach could be operationalized to inform cumulative effects information and decision making.

Critical Lessons Learned

- The ES Pilot provided a useful forum for learning about ES assessment, and for developing information about ES that is relevant, legitimate and credible.
- There is no one ES Approach. It is a framework that explicitly demonstrates connections between ecosystem services, functions, assets and the benefits that accrue to people. Alternatively it shows the degradation of some benefits due to decisions that involved trade-offs.
- There is a key difference between operationalizing an ES Approach and replicating one. Operationalizing is possible given an understanding of the steps that are relevant for application within a specific context, and an understanding of how to complete these relevant steps. No approach can be replicated due to the place-based contextual nuances of the issue, institutional arrangements, people involved, etc, and therefore each process to assess ES may look quite different.
- There are a number of key factors to consider when assessing the usefulness and effectiveness of applying an ES Approach. They include:
    - Is the issue compelling to the organization?
    - Is there a need for added and important cumulative effects information?
    - Is there support and are there sufficient resources to complete the assessment?
    - Is there an understanding and agreement on the scale of the assessment?
    - Is there sufficient data, internal capacity or access to capacity?
    - Is there capacity and the will to engage the decision-makers and key players/ networks in a timely fashion?

The ES Pilot team learned a great many things and did a number of things ‘right’ according to an internal evaluation; however there were a number of things, from a process and assessment perspective, that could have be done better. In some cases, these things may have been improved directly if there hadn’t been such heavy losses in team personnel throughout the project. One of the initial objectives in setting up and getting support for the ES pilot was “To explore and develop our ability to operationalize the ES approach to support decision making within ESRD”.

The next three sections speak specifically to that objective. The pilot demonstrated an approach to understanding and applying the ES Approach and has built some capacity and a deep experience with piloting an ES Approach. Two key learning's that frame a response to this objective are that there is no single ES Approach, and therefore, the approach cannot be replicated across different contexts.

4.1 Ideas about how to frame 'Operationalizing an ES Approach'

Ecosystem services is a concept designed to force us to acknowledge the different ways in which the environment supports human economies, the everyday lives of individuals, health and well-being, and sustainable communities. This concept can be used to communicate the importance of the environment in terms that people haven't considered previously, and can be used to focus research on how best to manage the environment to sustain human well-being.

The ES Pilot on Wetlands is an example of research designed to develop information that could lead to improved management of the environment to sustain human well-being. Many different activities, steps and approaches were used to develop the ES Pilot on Wetlands, in order to test methods and develop understanding and capacity for undertaking ecosystem service work. The entire approach used within the ES Pilot is described in the 'Operationalizing an ES Approach' document. The approach could be replicated in its entirety for future ESRD work on ecosystem services, or certain steps, activities and tasks could be undertaken to meet different and specific objectives. It is important to understand that the ecosystem services concept is flexible and is just one tool to help understand interactions between the environment and human societies within particular contexts.

In order to identify instances within ESRD when applying the ecosystem services concept might be useful, and then in order to develop a cost-effective, relevant and credible approach for considering ecosystem services within specific contexts, further capacity and expertise on ecosystem services across ESRD is needed. Ecosystem service work usually requires collaboration amongst several people from different disciplines, all of whom need to be well versed in ecosystem service science in order to be able to think creatively about developing ecosystem service information.

Greater expertise in ecosystem service science would allow ESRD to go beyond following generic steps for ecosystem service assessment to developing context-specific approaches to suit a multitude of information needs. Ecosystem service research is complex because it attempts to understand complex interactions between human societies, their economies and value systems, and the environment, at multiple scales and over time. Greater comfort with the flexibility of the ecosystem services concept and all the approaches currently used to understand ecosystem services would help in the identification of the parts of a system that need to be assessed in order to answer specific questions. This in turn would suggest what kind of approach could be used to complete an ecosystem services assessment as efficiently as possible.

There is no single 'ecosystem service approach'. Research on how to manage the environment to sustain human well-being can be conducted in many ways and may take on such forms as the following:

- Physical science research on how specific ecosystem services are produced, how they are changing, and how these changes are affecting humans.

- A short workshop with people from a region designed to understand how they specifically benefit from ecosystem services in order to gain a broader understanding of how people value and interact with the environment.

- A long, multidisciplinary assessment of multiple ecosystem services in an area designed to understand as much as possible about what ecosystem services are present in an area, how they are changing, how valuable they are and how best to manage them

- A modeling exercise to determine future changes in an ecosystem service and how this will impact people and businesses in a particular area.

- A field assessment to measure the exact production of ecosystem services in a small area (e.g. carbon storage or pollination).

- A desktop literature review to understand the benefits and values of one or multiple ES from a particular ecosystem.

Ecosystem service research that involves heavy engagement with stakeholders, the assessment of multiple ecosystem services, and the assessment of potential management strategies and future scenarios may be costly and take a long time. However, depending on information needs, ecosystem service research meant to add basic information to an issue with the simple goal of looking at a system from a new perspective may be accomplished with minimal resource commitments.

Research on how to manage the environment to sustain human well-being can be conducted at different scales, may require new data/information/expertise or already-held data/information/expertise, can be a stand-alone assessment or an add-on to existing project or programs.

4.2 Key Factors to Consider when Assessing the Use and Application of an ES Approach Application

There are a number of key strategic and operational factors to consider when assessing the usefulness and effectiveness of applying an ES Approach. They include:

- is the issue compelling to the organization?
- is there a need for added and important cumulative effects information?
- is there support and are there sufficient resources to complete the assessment?
- is there an understanding and agreement on the scale of the assessment?
- is there sufficient data, internal capacity or access to capacity?
- is there capacity and the will to engage the decision-makers and key players/ networks in a timely fashion?

a. Compelling issue to the organization

The ES Pilot took 16 months from inception to completion at a cost of approximately $450,000 and 10 full-time equivalent staff positions. This kind of commitment was important to pilot an ES Approach to support cumulative effects management in Alberta; however, future applications need to be mindful of the type and amount of resources needed to successfully complete an assessment. With limited resources it is critical to ensure that the application of an ES Approach, at least in the short to medium term, is focused on an issue that is truly significant and important to the decision-makers and leaders. In addition it is critical that the issue picked is one to which the ES Approach can provide inputs, for example, the ES Approach is about connecting human development with the benefits or degradation of important ES, it is not a process tool to solve interpretation issues about plans or policy.

It should be noted and is highlighted above that there are many inexpensive ways to do ES work, depending on what kind of information is needed. For example, 3 people, working half-time on an assessment of 2-3 ES in a particular area to add a new perspective to a particular issue, could probably complete the assessment in 3 months and with no huge costs. It would be useful for people reading this to understand that partly the costs were high because it was a pilot and you were trying to implement all the steps of the assessment. In some cases less emphasis on legitimacy (i.e. fewer resources on Steering Committee stuff, workshops etc) might be perfectly valid, if there is already a legitimate process in place and just highly credible information about a few ES is needed. In other cases, one workshop with stakeholders on ES might be useful to add to a project as it could inform decision-makers about the important ES in an area and this could help inform trade-off decisions. Very few ES assessments will cost as much as this pilot did; however the purposes of the pilot were to learn and develop tools that can help inform cumulative effects and decision-making and to build capacity; therefore these are also components incurred in the total.

b. Need for added and important cumulative effects information

Ecosystem Services information can be used for many different things and to inform different processes or issues. It was important within this relatively new ES program to ensure that there was a focus for the team and that it tied in tightly to ESRD’s priorities and therefore the ES Roadmap and subsequent pilot are focused on informing cumulative effects information for decision-making at this point in the ES program.

Given that the ES Program is coached under the Cumulative Effects banner, it is important, particularly in the early days with limited capacity and expertise, to ensure that future applications focus on the cumulative effects mandate and needs of the Cumulative Effects Management System. This will help to ‘focus and deliver on a priority of the government versus dabbling in many different areas without building a reputation and depth.

c. Support and resources to complete

In choosing an issue to apply the ES Approach the support and commitment to resources cannot be stressed enough. Figure 7 provides a snapshot of the organisational structure of the ES pilot and clearly shows the pilot champions and sponsors. Champions need to be briefed on the true ‘costs’ of delivering on an ES Approach and be continually updated on the issues and needs to ensure that roadblocks are acknowledged and solutions found in a timely manner. Having the ‘right’ level of support is also crucial to ensure that staff has a clear understanding of where they should focus. Budgets, operational planning documents and reporting structures should be set-up in advance of an ES Approach launch.

d. An understanding and agreement on the scale of the assessments

A number of reviewers of the Results report and early advisors on ES believed that with the resource intensity and time needs of doing an assessment that future assessments should take the learning from this place-based pilot and apply them to larger scales to inform regional and sub-regional planning and outcomes as this is a current focal area of the GoA and ESRD.

e. Data and information availability

Access to the right data and information is next to impossible to know up front as it depends on the results and learnings' from the steps in the approach. One note made at the March 2011 modelling workshop was that you will use about 20% of the data and information you generally collect and be missing 60% of what you need. This was a general comment about modeling projects in general but seemed to match the ES Pilot process. A designated person needs to be assigned to handle and manage the data and data relationships with those using the data and those from whom data is needed. Having a Geographic Information System (GIS) lead was crucial to manage and interpret both the data and also the needs of the ES pilot team from the data.

f. Internal capacity or access to capacity

At the outset of an application of an ES Approach there is significant need to assess the amount and level of internal capacity for each of the major aspects of the work. For instance, having access to scientists is not enough – very specific expertise for assessing each ES is needed. Setting this up in the project plan and charter would ensure that the team thinks through what expertise is needed at the beginning of the process. If the internal capacity and timing is not available there should be a good sense of where externally the expertise and capacity could be obtained and ensuring that these people are available and that the Project Manager is well set-up to develop contracts, Direct Purchasing Agreement or secondments to gain timely access to meet the needs.

g. Ability to engage the decision-makers and key players/ networks in a timely fashion

In association with understanding the issue, the key people around whom the ES Approach information is developed need to be clearly established at the beginning of the process. Strong relationships with these people will ensure that the assessment results will be relevant. The ES pilot benefited greatly from having these targeted decision-makers both on the Steering Committee and in semi-regular interview sessions.

h. Lessons learned from other work

The ES pilot project benefited greatly from the year relationship that the ES team had built with the World Resources Institute and a more recent two year relationship with the US EPA's Ecosystem Services team. These networks provided real and timely advice and interaction to support the ideas around the use and implementation of using an ES Approach and also provided the venue to share and learn from their experiences. Additionally, the ES Pilot benefited from a novel relationship build near the pilots inception with Dr. Neville Ash and other staff at the International Union for the Conservation of Nature. Dr. Ash was one of the lead authors of the then most recent publication about using ES assessments building off the analysis of case study work around the world. There were a number of key factors that the manual highlighted that framed the ES pilot design and in fact the manual was used as a key guiding document for the pilot work. Finally seeking out others, such as Dr. Ciara Raudseep-Hearne, with practical experience in both applying and assessing the results of ES assessments proved crucial to ensuring the team asked the right questions.

4.3 Key Factors to Consider when Designing and Implementing and ES Approach Application

Through the pilot there was also great learning about what is required to successfully complete an ES Approach Application. Beyond the relationships that were developed and integral to the design, implementation and completion of the ES pilot there were a number of factors that appear to have played a role in building process success. These factors are listed briefly below:

a. Scale

It is important that the assessment is at a scale that matches that of the biological and physical processes generating the ES being assessed and also at the scale relevant to the decision-makers (Ash et al. page 13). There may be multiple spatial and temporal scales under consideration. Although it is challenging to consider multiple spatial and temporal scales in a decision making process, this approach is crucial to obtaining a more complete view of the consequences of a decision on ecosystem services and, as a result, on human well-being and development goals. However there is often a lack of available biophysical methodologies to quantify ecosystem service magnitudes, as most quantification studies utilize economic valuation technique.

b. A clearly set-up and maintained project scope, limitations and boundaries

Building clear boundaries, objectives and scope was a critical first step for the pilot to ensure that all participants knew where the pilot was going. There were a number of team members in early sub-team work that 'wished' the pilot would modify the scope to include agricultural wetland loss as they believed it to be the bigger problem; however with a clear and oft reiterated scope conversation were able to move back to point and expectations were successfully managed. As the ES concept is promoted within ESRD, scoping phases for any potential application of the ecosystem services concept could be useful. This might involve considering the proposed project, policy or program that the ES concept could be applied to and asking the following questions:

- What would the consideration of ES and the people who benefit from them add to our understanding of the issue?
- From a political or information perspective, would it be useful to consult with people about how they benefit from ecosystem services within a given context? If not, could we conduct a simple desktop literature review or modeling exercise to understand the ecological and social dynamics around specific ecosystem services?
- Do we have relevant data and expertise in order to answer questions about specific ecosystem services within this context? If not, is the issue important enough to hire additional people to conduct ecosystem service research?
- When would we like the research to be completed? (i.e. when is the information needed?)
- Do we have specific questions about certain ecosystem services, or do we more generally want to learn about what ecosystems services are most relevant, or which ecosystem services even exist, within a certain area?

c. Truly collaborative approach

Once the boundary and scope were understood, the pilot team adopted a truly collaborative approach in which those on the teams and sub-teams had equal opportunity to question, influence and participate in the work. In an evaluation discussion at the final Steering Committee meeting, one member noted that this was one of the 'most truly participative and inclusive projects' they had worked on. Unlike other projects this pilot truly consulted with team members, it was 'no rubber stamp' exercise. This helps to build legitimacy and credibility in the process.

d. Communication and A single key point of contact

Having a clear plan to communicate to the various teams was important to ensure inclusivity, access to information, clarity on work, roles, timelines and next steps.

The 'face' of the ES pilot was the Project Manager which helped to create a point of contact for help, questions, etc. While this was an enormous task, it was helpful, especially with 44 team members from around the world. When sub-teams were set-up those lead were then the point of contact for set tasked and deliverables. Having key point people was noted as helpful.

e. Humility and expose assumptions and limitations

There is clear understanding from the pilot team that over promising any deliverables is the 'kiss of death' to future opportunities within the GoA. There are too many examples of over-promising and under delivering that the team learned from. When this reality is mapped against the difficulty in understanding ecosystems and ES there is a high importance to be humble about what can be expected and how far the work can take us to solutions. It is critical that those, excited but the work and possibilities, do not over sell the concept or results.

f. Conflicts and perceived risks of the work

The Ecosystem Services program is relatively new in ESRD and has not enjoyed a wide introduction and education to staff. One of the effects of this was that some staff and managers were hesitant and some even suspicious of what this ES pilot was doing. Was it replacing some other 'tool' within the Ministry? Was it in conflict with other work that was underway? What this some 'pet project' that enjoyed Director level support because of the influence and networks of a few select people? It was important to have a clear, consistent and timely communication about what the intention and fit of the pilot was. Additionally, it was potentially an important point that the Project Manger moved quickly to meet with or present to groups that had concerns or incorrect information about the pilot to dispel myths and build a common understanding.

5. Conclusions and Recommendations

The ES Approach Pilot on Wetlands was successful in that the team learned about how to operationalize an ES Approach and the opportunities to do a number of different processes and methods to try and complete the steps. A number of results were also considered useful to the decision-makers. There were also a number of lessons learned and things that could be done differently or better to achieve credible and policy relevant results. Most of these lessons learned have been captured in each of the chapters and will not be repeated here. Audiences are encouraged to review specific learning's or all that are worthwhile for their circumstance or interest.

Two key conclusions are:

- There is no one ES Approach and the need for an ES Approach to be contextualised to the place, scale and issue is critical to building for success.

- Using an ES Approach can inform the Government of Alberta's cumulative effects management system work and should be used strategically to build capacity and understanding while also filling important gaps in information.

As noted there are a number of related reports that form the entire body of work of the ES pilot. Specific to operationalizing an ES approach and building upon the recommendations presented in the Integrated Results Report (pages 76 – 78) there are a number of process recommendations. These recommendations are made both for the generic ES Approach process (i.e. making it more effective) and for the longer term use of an ES Approach within ESRD and the Government of Alberta.

a. Process Recommendations

- In general, there are many different ways to use ES information and ES assessment processes. This provides a number of opportunities for the GoA to be innovative and creative, which should be encouraged. More specifically, those interested in ES should carefully consider and explain how ES can benefit a project or issue and how the results can be used to ensure focus and that you deliver relevant results.

- The ES pilot was a full scale pilot that required significant time, money and resources. To assess how the work could be more efficient and/ or less resource intensive, it would be useful if ESRD could evaluate what types of issues and projects could benefit from ES work in ESRD and then assess how much of the 6-step process is required to deliver useful information. For example not every project requires scenarios to be built or economic valuations to provide beneficial ES information.

- It is recommended that ESRD look at how the ES approach could be implemented at different scales and in complement with other work, such as regional planning, to better understand the data needs, costs and resource implications. This would help to inform where the limited ES capacity should be focused for maximise effectiveness for ESRD.

- The world has limited ES professional capacity and even people with some experience often are not deeply experienced. It is likely that even 'experts' are more experienced in a particular technical field (e.g. hydrology, economic analysis) than in ES itself. The recommendation is to provide enough time and resources to support more learning on-the-task than your professional staff usually need.

- The field of ES is evolving rapidly and ideas are changing every year. Professional staff cannot entirely rely on ideas and literature that is even a few years old, including the Millennium Assessment. Efforts need to be included to find out what ideas are current and reliable, on your start date. All projects have challenges with team work, goals and other issues of project management. Because of limited knowledge and evolving standards of ES (mentioned above) project management tasks will be even more challenging than usual. Provide more time and resources to project management than would be necessary for a project of equal size, on a more traditional topic.

b. Alberta Environment and Sustainable Resource Development/GoA Recommendations

- The pilot has not only enhanced awareness, but also built capacity in ESRD and the Government of Alberta more broadly through the collaborative and engaging processes incorporated throughout the project.

- Within the government Cumulative Effects Management System (CEMS) context it would be very useful for the ES Program team to look at where and how this work fits into decision-making and then to go through a process of prioritisation. As the capacity and number of staff working in this area is still small, it is important to ensure that that there be a longer term vision for ES, such as is articulated in the ES Roadmap, and that there are shorter term milestones, projects and areas of influence to build the credibility and legitimacy of the approach.

- Two specific recommendation include reviewing the revising the ES Roadmap with the new learning accumulated through this ES Pilot and also to take a look at opportunities to use ES to inform decision-making, for example, by looking for point so connection with the ideas present in Figure 1.

- The process, including routine 'lessons learned' activities, also provided the opportunity to test and provide further refinements to the Alberta ES Approach, further contributing to longer term goals of the ES Road Map.

- Review and implement opportunities to use ES to inform decision-making. Lessons from the ES Pilot indicate that selectively adopting an ES approach for key issues will support and enable ESRD's work on cumulative effects management, policy development, planning, and decision-making.

- Developing and delivering a cumulative effects management system is one of the department's main priorities. An ES approach supports this priority by allowing ministries and stakeholders to explore and understand the interdependencies that exist between development decisions and the environment. Identifying and understanding these connections at the point of decision-making, and not as a consequence of past decisions, will enable decision-makers to make more informed decisions and proactively manage risks and opportunities. In turn, this will ultimately improve cumulative effects management on the landscape.

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Appendix 1: Data and Information Layers

DATASET	DATA SENT TO CONTRACTORS
Shepard Boundary	EMS groundwater licenses
City, Town, Hamlet	EMS surface water licences
Census Stats (2001, 2006)	Drained Wetland Inventory – Current
Dissemination Blocks	Drained Wetland Inventory – Historic
Surficial Geology	Base Features Cutline/Trail
Bedrock Geology	Base Features Pipeline
DUC's Drained Wetland Inventory (2005)	Base Features Powerline
DUC's Drained Wetland Inventory (Historical)	Base Features Railway
Chinook Construction Wetlands	Base Features Road
Hydrology Arcs	Base Features ATS Section
Hydrology Polygons	Base Features ATS Township
Strahler Stream Order	Base Features City
Roads	Environmentally Significant Areas
Pipelines	Base Features Indian Reserve
Cutlines/Trails	Base Features Irrigation District
Powerlines	Base Features Metis Settlement
Railways	Base Features Town
Indian Reserves	Base Features Hydro Polygon
Metis Settlement	Base Features Hydro Arc
Irrigation District	Bedrock Geology
PFRA Sub-basins	Bow River Basin Strahler Stream Order
PFRA Major basins	PFRA Effective Drainage Area
PFRA Incremental Gross Drainage Area	PFRA Effective Drainage Areas of the Incremental Drainage Areas
PFRA Effective Drainage Area	PFRA Gross Drainage Areas
PFRA Effective Drainage Areas of the	PFRA Major Basins

Incremental Drainage

PFRA Areas of Non-Contributing Drainage

PFRA Major Drainage Systems

DEM (25m)

Slope (25m)

Contours (10m)

LiDAR

GVI

Agrasid

Soil Salinity

ERCB Well Drilling Occurrence

ERCB Well Licensing

IHS Pipelines

IHS Facility Points

IHS Oil and Gas Wellsites

Species Mgmt. Area - Black Bear

Species Mgmt. Area - Elk

Groundwater Licenses

Groundwater Registrations

Surface Water Licenses

Surface Water Registrations

Land Ownership

ATS Townships

ATS Sections

ATS Quarter Sections

ATS LSD's

SSRP Groundwater Vulnerability

PFRA Major Drainage Systems

PFRA Areas of Non-Contributing Drainage

PFRA Sub Basin

Groundwater Vulnerability (SSRP)

ACIMS Element Occurrences (Non Sensitive)

Species Management Area – Antelope

Species Management Area – Black Bear

Species Management Area – Elk

Species Management Area – Grizzly Bear

Species Management Area – Moose

Species Management Area – Mule Deer

Species Management Area – Sheep

Species Management Area – White Tailed Deer

Shepard Drainage Boundary

Soil Salinity

Surficial Geology

ACIMS Element Occurrences (Sensitve)

AGRASID

GVI (Shepard drainage area)

Aquatic Environmentally Significant Areas (AESAs) - F

City of Calgary – Sanitary data

City of Calgary – Storm water management data

City of Calgary – Water network infrastructure data

City of Calgary – Land Cover (IDP LLC)

City of Calgary - Soils

Historical Imagery Mosaic - (from project 81-167P)

ESA's

AESA's

SPOT 2010 Imagery

SPOT 2006 Imagery

City of Calgary Sanitary Data

City of Calgary Storm Water Mgmt. Data

City of Calgary Water Network Infrastructure

City of Calgary Land Cover

City of Calgary Land Use

City of Calgary Soils

Calgary Phase 1 SK Wetlands

Calgary Phase 2N SK Wetlands

Calgary Phase 2S SK Wetlands

Calgary Phase 5 SK Wetlands

LiDAR – Shepard Drainage Area (Calgary East)

SPOT Imagery (2006)

SPOT Imagery (2010)

Appendix 2: Ecosystem Services Classification – Draft List

Various Sources[7]	Millennium Ecosystem Assessment (2005)	The Economics of Ecosystems and Biodiversity (TEEB)	The Ecosystem Services Pilot Project on Wetlands
Provisioning • Food • Water supply • Raw materials • Fuel and energy • Genetic materials • Drugs and pharmaceuticals	**Provisioning** • Food • Fresh water • Fibre and fuel • Genetic resources • Biochemical products	**Provisioning** • Food • Water[8] • Raw materials • Genetic resources • Medicinal resources • Ornamental resources	**Provisioning** ***1.*** Food ***2.*** Fresh water ***3.*** Raw materials ***4.*** Genetic resources ***5.*** Drugs and pharmaceuticals
Regulating • Gas regulation/ air quality • Favourable climate (incl. carbon sequestration) • Storm protection • Flood prevention • Drainage and natural irrigation (drought prevention) • Clean water (waste treatment) • Erosion control • Pollination • Biological control	**Regulating** • Climate regulation • Water regulation • Water purification and waste treatment • Erosion regulation • Natural hazard protection • Pollination	**Regulating** • Air purification • Climate regulation (including carbon sequestration) • Disturbance prevention or moderation • Regulation of water flows • Waste treatment (especially water purification) • Erosion prevention • Maintenance of soil fertility (incl. soil formation) and nutrient cycling • Pollination • Biological control	**Regulating** ***6.*** Carbon storage ***7.*** Climate regulation ***8.*** Nutrient retention ***9.*** Flood prevention ***10.*** Water regulation ***11.*** Pollination
Supporting • Soil formation	**Supporting** • Soil formation • Nutrient cycling	**Supporting/ Habitat** • Lifecycle maintenance • Gene pool protection	**Supporting** ***12.*** Habitat ***13.*** Soil formation
Cultural • Spiritual/ traditional use • Recreational • Aesthetic • Science and education	**Cultural** • Spiritual and inspirational • Recreational • Aesthetic • Educational	**Cultural and Amenity** • Aesthetic information • Recreation and tourism • Inspiration for culture, art and design • Spiritual experience • Information for cognitive development	**Cultural and Amenity** ***14.*** Aesthetic ***15.*** Recreation and tourism ***16.*** Inspiration for culture, art and design ***17.*** Spiritual ***18.*** Traditional use (Aboriginal)

[7] Southern Alberta Landscapes Phase II, Version II (2008); IUCN Integrated Wetland Assessment Toolkit (2009); and, DeGroot, Valuing Wetlands (2006).
[8] In the TEEB assessment, the consumptive use of water is placed under provisioning, instead of 'regulating' as often it is categorized.

Appendix 3: Limitations of Suggested Methodologies and Other Considerations

AWRI Wetland Health Project

The work of the AWRI Wetland Health Project has focused on the creation of four different quantitative indices to measure the health of semi-permanent (Class IV) and permanent (Class V) wetlands in the Beaverhills Sub-watershed. These indices include a Disturbance Gradient (based on physical, chemical and morphological metrics), an Index of Biotic Integrity and Floristic Quality Assessment (based on biotic communities) and a Rapid Assessment Method (RAM) (based on a combination of wetland and buffer zone characteristics). While the biotic indices perform very well in the study area, they have not been tested in other regions of the province or on other classes of wetlands. Consequently, it is unknown whether metrics, such as shoreline slope, % area of open water, and % area of wet meadow, are generalized to other classes of wetlands, or to other regions of the province. Calibration of these metrics, or the development of a disturbance gradient for the Shepard Slough, may be required before these three metrics can be used.

Riparian Health Assessment – This assessment tool has been tested and adapted for Alberta. This assessment was originally developed by the University of Montana through their Riparian and Wetland Research Program. Testing and refinement of the method has occurred in Montana, Idaho, Wyoming, North Dakota, South Dakota, Alberta, British Columbia and Saskatchewan. It is widely used in Alberta on both public and private land (To be used with the Riparian Vegetation Classification guide). The 9 questions relate to the ecological functions of the riparian area which in turn affects their stability, resilience and ability to provide ecological services.

This rapid assessment does not include water and soil chemistry indicators or slope as the AWRI method listed above. It is not designed for an in depth, comprehensive analysis. A riparian health inventory is used at the drainage or watershed scale. The first question in the assessment regarding vegetation does provide a key indication of the trend away from the expected vegetation for the site. Only use to compare adjacent wetlands of a similar size and type within the area and between repeated assessments of the same site. This health assessment can be used to monitor trend if done at the same site at the same time on a subsequent year. A single assessment cannot define the absolute status or indicate trend.

Wetland Ecosystem Services Protocol for the United States (WESPUS)

As stated in protocol document this method has not been tested or calibrated widely. There are several questions for each of the 81 indicators which will ensure thoroughness of the assessment but may not necessarily be considered a rapid assessment.

According to Dr. Adamus, the academic community, especially engineers, note that this is not a mechanistic model. It is based on logic and available literature, and as such it reflects the lack of understanding of wetland processes. The model uses indicators, rather than variables that take more time and expensive equipment but which may be more predictive.

From the general public, the response has been positive, particularly because the model is transparent.

Appendix 4: Methodologies for Undertaking a Condition Assessment

Ecosystem Service Categories	PROPOSED ES	Scale of production	Scale of consumption	Potential methods	Potential indicators	Additional sources of information
Provisioning	Food	Site/ Region	Region/ global			
	Fresh water	Site/Region	Site/Region			
	Raw materials	Site/Region	Site/Region			
	Genetic resources	Site/Region	Site/Region			
	Drugs and pharmaceuticals	Site/ Region	Region/ global			
Regulating	Carbon storage	Site/ Region	Region/ global	SEE Ducks Unlimited Method		
	Climate regulation	Site/ Region	Region/ global			
	Nutrient retention	Site/Region	Site/Region		N concentration S concentration	
	Flood prevention	Site/Region	Site/Region			Previous flood reports Flood modeling
	Water regulation	Site/Region	Site/Region			
	Pollination	Site/Region	Site/Region			
Supporting	Habitat	Site/Region	Site/Region			
	Soil formation	Site/Region	Site/Region			
Cultural and Amenity	Aesthetic	Site/Region	Site/Region			
	Recreation and Tourism	Site/Region	Site/Region			
	Inspiration for culture, art and design	Site/Region	Site/Region			
	Spiritual	Site/Region	Site/Region			
	Traditional use (Aboriginal)	Site/Region	Site/Region			

Assessment Name	**Wetland Characteristic***	**Associated ES**	**Method of Assessment (field vs. desktop)**	**Scale of Assessment (site vs. regional)**	**Spatial Data Requirements for Desktop**
AWRI Wetland Health Project	Size, location, boundaries, permanence	Aesthetic, Recreation Science & Education, Water Supply, Spiritual, Cultural	Field or Desktop	Site & Regional	Airphotos (time series) and Lidar DEM
	Shoreline slope**	Biodiversity	Field or Desktop	Site	Lidar DEM

	% Open Water** % Wet meadow**	Habitat, Biodiversity			Lidar DEM
	Sediment P & N concentration	Water Purification, Nutrient Retention, Nutrient Cycling	Field, but can potentially be modeled	Site & Regional	Wetland inventory & land use data
	Winter-time temperature, O^{18} Isotope	Hydrological Regimes	Field & desktop	Site & Regional	Landsat Thermal Imagery
	Winter-time temperature, O^{18} Isotope Water storage capacity Wetland connectivity	Flood Control	Desktop	Site & Regional	Landsat Thermal Imagery & Lidar DEM
	Depth of organic matter	Gas Regulation, Climate Regulation	Field	Site	N/A
	Primary production (biomass)	Habitat, Biodiversity	Field	Site	N/A
	Plant Community Structure % Invasive Species	Habitat, Biodiversity, Aesthetic	Field	Site	N/A
Riparian Health Assessment (Ambrose et al. 2004) http://www.cowsandfish.org/riparian/health.html Riparian Classification for the Grassland Region – available only in paper copy (link below) http://www.cowsandfish.org/order_tools.aspxLink for ecological site/plant community guide for Foothills Fescue subregion located below this table.(Adams et al. 2003)	Vegetative cover of riparian area	Primary production, erosion reduction, shore stabilization, water purification, water supply, flood control, nutrient cycling/ retention, nutrient cycling, soil formation/ development, hydrologic function, wildlife habitat, socio cultural (traditional plants/medicines), aesthetics, biodiversity, disturbance regulation	Field	Site	*data (polygons)on public lands captured spatially and stored electronically – Rangeland Management Branch Edmonton- Contact Jordan Erker
	Invasive plant species (Canopy cover, Density distribution)	(adversely affect) biotic integrity, hydrologic function/regimes, food production, wildlife habitat/refugia, aesthetic, traditional use	Field	Site	
	Disturbance-caused undesirable herbaceous species	(Adversely affect) Site stability, hydrologic function//regimes, erosion control, water purification potential, flood control, socio-cultural values(aesthic, traditional use, wildlife habitat, refugia, biodiversity	Field	Site	
	Preferred tree and shrub establishment and regeneration	Site stability, erosion control, flood control, water purification, socio-cultural values(aesthetics, traditional use, wildlife	Field	Site	

		habitat/refugia, hydrologic function/regimes			
	Utilization of preferred trees and shrubs	Relates to potential for reduced capacity to provide ES as listed above in preferred shrub and tree establishment and regeneration	Field	Site	
	Human alteration of riparian area – vegetation	Affects erosion control, water purification, hydrologic function etc as outlined in ES for vegetation cover above	Field	Site	
	Human alteration of riparian area – physical	Affects production of water purification, flood control, hydrologic function	Field	Site	
	Human-caused bare ground	Affects food production, erosion control & sediment retention, flood attenuation, water purification, biotic integrity,food production hydrologic function/regimes, biodiversity, wildlife, disturbance regulationhabitat/refugia	Field	Site	
	Degree of Artificial addition/removal of water	Affects ability of site to provide food, erosion control, biotic integrity, flood control, wildlife habitat/refugia	Field	Site	
Wetland Ecosystem Services Protocol for the United States (WESPUS) http://people.oregonstate.edu/~adamusp/WESPUS/WESPUS_beta_v1_FieldF.pdf	Please use link to the left for further information as there are **81** questions in the protocol				

http://www.srd.alberta.ca/BiodiversityStewardship/GrazingRangeManagement/documents/FoothillsFescueSubregionAssessmentGuidelines.pdf