Identifying the Scope and Objectives of the Wetland Monitoring Program

A Three-Phased Stakeholder Engagement Process

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Alberta Environmental Monitoring, Evaluation, and Reporting Agency

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June 30th 2016

Executive Summary

In the boreal region of Alberta, wetlands are a dominant landform and provide a wide range of critical ecosystem functions and services. Despite their recognized importance, wetlands face increasing pressure from human activities. Stakeholders are numerous in this area and their interactions with wetlands vary. The Biodiversity Component Advisory Committee (CAC) of the Oil Sands Monitoring (OSM) program identified the need for a regional monitoring program to support the various monitoring and management needs of the stakeholders. In response to this initiative, the Alberta Environmental Monitoring, Evaluation, and Reporting Agency (AEMERA) tasked the Alberta Biodiversity Monitoring Institute (ABMI) with developing a wetland monitoring program for the Oil Sands region.

Recognizing the various land uses occurring in the region and the related management and monitoring needs of stakeholders, we identified an engagement process as the best means of successfully developing the program's scope and objectives. We developed and implemented a participatory, multi-stakeholder approach to engage over 70 technical, regulatory, wetland, and stakeholder experts. From November 2015 to April 2016, the ABMI undertook a three-phase stakeholder engagement process by:

1. Conducting interviews to identify management and monitoring needs;
2. Administering a survey to prioritize management and monitoring needs; and
3. Hosting a 2-day workshop to seek collective agreement on the program's foundation and framework.

Through this stakeholder engagement process, wetland experts and stakeholders collectively agreed that the wetland monitoring program should:

- Be guided by a set of principles:
    - Relevance: The goals, questions, and direction of the monitoring program must be realistic and relevant to supporting the cross-disciplinary needs of stakeholders.
    - Cost-effectiveness: The monitoring program must recognize its limitations and strive to be efficient, effective, and avoid duplicating existing efforts.
    - Accessibility: Provide data and protocols that are freely and easily accessible.
    - Timeliness: Report data and findings to stakeholders in a timely fashion.
    - Scalability: Allow the program to be tailored and expanded to meet additional monitoring needs or questions.
- Have two main goals:
    1. Monitor the condition of wetlands in the Oil Sands region and measure the cumulative effects of natural and anthropogenic factors on wetlands; and
    2. Detect changes in wetlands that can be associated with specific anthropogenic activities (sector, operator/site-specific) and can be differentiated from natural environmental effects.
- Have three monitoring objectives and associated questions:
    1. Collect baseline information:
        - *What is the natural range of spatiotemporal variability in the condition of wetlands?*
    2. Detect and characterize wetland change:
        - *Does wetland condition change over time*?
        - *What is the amplitude and extent of the change?*
    3. Attribute the observed change to its cause:
        - *Do anthropogenic or natural factors cause the conditions of wetlands to change*?

- Be composed and integrate both field surveys and remote sensing components.
- Include the development with continual enhancement of a wetland inventory and/or enhance the existing layers (e.g., Alberta Merged Wetland Inventory).
- Tease apart the effect of natural factors (e.g., natural climate variability, wildfire, pests) from the effect of land use activities.
- Trigger decision-making that is scale appropriate, i.e., regional or sector/site-specific, when change is observed.
- Support the needs of key federal and provincial policies and legislations, with the Alberta Wetland Policy, the Land-use Framework, the *Environmental Protection and Enhancement Act*, and the Water for Life Strategy being the highest priorities.
- Provide information that facilitates management of specific and cumulative effects of anthropogenic activities on wetlands. Anthropogenic activities include mining, oil and gas, forestry, agriculture, and urban development.
- Be integrated into a monitoring framework where collected information can be used for testing and refining hypotheses and designing complementary research to:
    1. Advance understanding and knowledge; and
    2. Improve management decisions.

We used the input provided by wetland experts and stakeholders to support the recommendations provided in the Final Report.

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Acronyms

ABMI	Alberta Biodiversity Monitoring Institute
AEMERA	Alberta Environmental Monitoring, Evaluation, and Reporting Agency
AER	Alberta Energy Regulator
AWCS	Alberta Wetland Classification System
CAC	Component Advisory Committee
CEMA	Cumulative Environmental Management Association
EPEA	*Environmental Protection and Enhancement Act*
OSM	Oil Sands Monitoring Program
NGO	Non-governmental organization

1. Introduction

The Oil Sands region represents about 20% of Alberta's landscape, and wetlands are a dominant ecosystem in the region (Graf 2009). Various anthropogenic activities (e.g., industrial, commercial, agricultural, forestry, and/or urban development) occur simultaneously in this region. Stakeholders are therefore numerous and their interactions with wetlands vary. While some stakeholders use wetlands to support their recreational and cultural activities (Davis 2005), others, such as energy industry representatives, often interact with wetlands for compliance reasons (Alberta Energy 2016). Depending on their interactions with wetlands, stakeholders have specific needs relating to a wetland monitoring program. For example, while hunters need information to protect wildlife habitat, the energy industry needs information on the regional and natural variability of wetlands to help in understanding targets for reclamation and remediation.

Recognizing the various land uses occurring in the region and the related management and monitoring needs of stakeholders, we identified an engagement process as the best approach for successfully developing the program's scope and objectives. Therefore, we selected a participatory, multi-stakeholder approach to encompass the diversity of interests, needs, and positions regarding the monitoring program. We selected this approach to increase the likelihood that the developed program would be useful to a majority of stakeholders while being effective and feasible to implement.

We engaged diverse sets of wetland experts and stakeholders throughout this process. By engaging with groups, we aimed to hybridize the scientific knowledge of wetland experts with the implicit and context-dependant knowledge of stakeholders, which is thought to lead to a more relevant and scientifically-credible monitoring program (Stringer and Reed 2007).

In this context, the best approach to program development was to engage wetland experts and stakeholders in discussions that, instead of seeking consensus among participants, involved the "shared adversity principle" (Steinman et al. 2002), which recognizes that trade-offs are inherent to decision-making. With this principle in mind, the data collected through the engagement process were summarized and synthesized and ultimately used to develop different components (e.g., scope, goals, monitoring questions, and sampling design) of the program.

The engagement process included three main multi-stakeholder consultation phases. Wetland experts and stakeholders were invited to participate in: 1) an interview, 2) an online survey, and 3) a workshop (Figure 1).

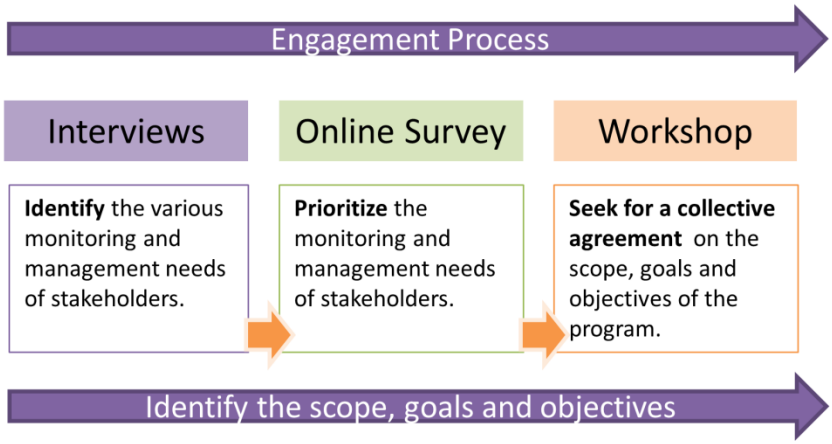

Figure 1. The engagement process included a series of interviews, an online survey, and a workshop. The goal of the engagement process was to identify the scope, goals, and objectives for the wetland monitoring program that best support stakeholder needs.

During the interviews we encouraged individuals to discuss their management and monitoring needs associated with wetland monitoring. Information collected during the interviews was summarized and synthesized with the goal of identifying overlapping needs. Using the outcomes of the interviews, we transformed the identified needs into a series of potential monitoring goals and objectives and, using an online survey, we asked the same stakeholder and wetland experts to prioritize them. Data collected from the survey and interviews were then used to draft the scope of the monitoring program and its framework. We then presented the goals, objectives and monitoring framework to the same wetland experts and stakeholders during a workshop hosted by AEMERA and the ABMI on March 16 and 17, 2016. The workshop's main objective was to seek a collective agreement with and among the stakeholders about which monitoring goals and objectives should be prioritized for this program. In addition, the workshop aimed to collect further input from stakeholders to better align the proposed monitoring program and framework with their needs.

This report provides the following:

- A description of the Interview process;
- A summary of responses from the wetland experts and stakeholders to each of the interview questions;
- A description of the survey process;
- A summary of the results from the survey;
- A description of the workshop; and
- A summary of the outcomes and key messages from the workshop.

All documentation from the engagement process, such as interview questions, survey, workshop agenda, and presentations, can be found in a separate Supplemental Information Report, which is referenced throughout this report.

2. Interviews: Identifying the Management and Monitoring Needs

The first phase of the stakeholder engagement process consisted of a suite of interviews. We determined individual and small group interviews to be the best approach to discussing and identifying the breadth of stakeholder needs. More specifically, the goals of the interviews were to:

1. Identify the management and monitoring needs of the various stakeholders;
2. Summarize and synthesize their needs; and
3. Derive a list of potential goals and objectives for the program.

This section describes the following:

- The process for selecting participants and conducting interviews.
- A summary of the responses to each of the six interview questions.

While this section describes the interview process and outcomes, the documents provided to the interviewed wetland experts and stakeholders are available in the Supplemental Information Report.

2.1. Selecting Participants and Conducting Interviews

Wetland experts and stakeholders from government, academia industry, and other sectors were consulted to discuss and identify the foundational scope, objectives, and management needs for an integrated (field and remote sensing) wetland monitoring program. This took place from the end of October, 2015 through January, 2016. Over this period, the ABMI technical team met with 50 wetland experts and stakeholders. Of those individuals, 18 represented government (three federal and 15 provincial), eight were from academia, five worked in industry (four in oil and gas and one in forestry), eight were from environmental non-governmental organizations (NGO), seven were environmental consultants, and three worked in environmental monitoring.

The engagement process was structured to ensure that it met stakeholder engagement practice requirements, as defined by Reed (2008). This stakeholder engagement practice focuses on four principles to ensure: 1) solicitation of the relevant participants and experts, 2) engagement of stakeholders early and often in the process, 3) empowerment of discussion and feedback, and 4) skilled facilitation.

Four Principles of Stakeholder Engagement

1. Solicitation of the relevant participants and experts
2. Engagement of stakeholders early and often in the process
3. Equal opportunities to participants
4. Skilled facilitation

Principle 1: Ensure that relevant participants are selected to participate.
The key sectors[1] directly or indirectly interacting with wetlands in Alberta were identified as:

- Government (federal, provincial, and municipal)
- Industry (e.g., oil and gas, agriculture, forestry)

[1] First Nations and Métis were also identified as key stakeholders. Their engagement with the development of this wetland monitoring program was led by AEMERA.

- Environmental non-governmental organizations
- Academia
- Environmental consulting
- Environmental monitoring

Within each sector, a suite of wetland experts and stakeholders were solicited as potential participants based on their relevance, knowledge, background, and expertise. Potential participants were identified based on one or more of the following criteria:

- Influences wetland management decisions, actions, and/or policy
- Affected by wetland management decisions, actions, and/or policy
- Has extensive knowledge about/experience with wetland ecosystems
- Has extensive knowledge about/experience with wetland monitoring systems
- Has extensive knowledge about/experience with remote sensing tools relevant to wetland monitoring
- Uses wetland data and related information
- Conducts work associated with wetlands in Alberta
- Conducts work associated with wetlands specifically in the Oil Sands region

Once identified as a relevant participant, the wetland experts and stakeholders were solicited via e-mail to participate in a meeting (one-on-one or group meetings). In total, 89 people were identified as potential participants in the engagement process. From the list of potential participants, a total of 50 accepted the invitation and participated in the interviews (Table 1). To expand our network of connections, additional relevant and potential participants were identified through e-mail and phone correspondence and during interviews.

Table 1. Number of interview participants by sector.

Sector	Potential participants	Interviewed wetland experts and stakeholders
Federal government	4	3
Provincial government	24	16
Academia	24	8
Industry	10	5
NGO	11	8
Environmental consulting	7	5
Environmental monitoring	7	3
Other	2	2
Total	**89**	**50**

Principle 2: Engage with experts and stakeholders as early as possible and throughout the process. Interviews were the first of three steps in the engagement process. Engaging with stakeholders early in the decision-making process has been frequently identified as crucial if participatory processes are to result in high quality, transparent, and durable decisions (Reed et al. 2006). By seeking wetland expert knowledge and by taking into account stakeholder interests and concerns as early as possible, we aimed

to inform the design of a wetland monitoring program with a variety of perspectives and increase the likelihood that needs associated with such a program would be successfully fulfilled. Furthermore, engaging with wetland experts and stakeholders throughout the process provided the participants with opportunities to offer inputs, review proposed decisions, and be involved in project outcomes.

Principle 3: Provide equal opportunities to participants while ensuring that the selected methods of engagement are relevant.

The interviews were intended to provide equal opportunities to the participants. We ensured that each participant had the opportunity and technical capability to be fully and effectively engaged in the discussion. Each participant had the ability to express opinions and provide input. Dissimilarities in experience, education and/or technical background were overcome by conducting one-on-one interviews or, when suggested by the participants themselves, by conducting small group interviews with same-sector participants. The interviews were held either in person or over the phone.

We developed a six-question questionnaire to facilitate discussions during the interviews and to ensure consistency throughout the entire process (see questionnaire in the Supplemental Information Report). The questionnaire was reviewed by an Environmental Sociology professor at the University of Alberta, who assisted in tailoring the questions to participants with various backgrounds and knowledge bases. Prior to the interviews, each participant was provided the same set of information, including: 1) a one-page document with a project overview (see project overview in the Supplemental Information Report), and 2) the interview questionnaire. In the questionnaire, technical words were defined to ensure that terminology used during discussions was consistent. Throughout the interview, participants were strongly encouraged to ask any follow-up questions about the project and the questionnaire and add any relevant additional details to their answers. The goal was to inform the participants and develop the required knowledge and confidence necessary for each participant to meaningfully engage in discussion (Reed 2008).

Principle 4: Ensure skilled facilitation.

The interviews were conducted by impartial facilitators who were approachable and open to multiple perspectives (Reed 2008). The facilitators aimed to maintain a positive group dynamic, encourage participants to question assumptions, and re-evaluate entrenched positions (Reed 2008). The meetings and discussions were conducted by three facilitators with a range of relevant expertise essential to the development of the program, including hands-on skills in wetland ecology, remote sensing, monitoring, and environmental policies and resource management.

To ensure the quality of information presented to participants was consistent among meetings, each facilitator was given an *a priori* set of tasks when conducting the interview. Each interview was conducted following a similar format and procedure. At the beginning of each meeting, Facilitator I provided background and an overview of the project, as well as answered questions from the participants regarding the project. After an initial introduction, Facilitator II explained the terms of the questionnaire, guided the participants through the questions, and facilitated discussions with and among participants. Facilitator III took notes during interviews and was responsible for communicating with the participants before and after the interviews.

2.2. Interview Outcomes

Following each interview, notes were compiled and entered into a spreadsheet categorized by individual participants and questions. The feedback for each question is synthesized in the sections below. In addition, the context and main goal of each question is provided. All responses were kept anonymous to encourage the participants to speak freely, and to support transparent, bi-partisan, and open stakeholder engagement.

For each question discussed during the interview, the collected information has been summarized and synthesized with the goal of representing both the commonalities and the range and diversity of opinions.

We further summarized management and monitoring needs under four potential monitoring objectives and a suite of potential variables to monitor. The feedback was analyzed and summarized to identify overlap and alignment in management and monitoring needs among sector types.

Interview Questions

1. What classes of wetlands does your sector interact with? Which wetland classes should the Monitoring Program assess?
2. Should the Monitoring Program assess natural and restored/reclaimed/created wetlands?
3. What are the wetland management and monitoring needs of your sector?
4. What is the best approach for the Monitoring Program?
5. What should a good wetland monitoring program accomplish? What should it allow stakeholders to do?
6. What are the unknowns in wetland condition?

2.2.1. Summary Messages

Although wetland experts and stakeholders came to the interviews with diverse backgrounds and opinions, there were a number of common themes. The following messages have associated caveats (see details under each question), but the majority of the participants agreed that the wetland monitoring program should:

- Collect field and remote sensing data;
- Develop a wetland inventory and/or enhance the existing layers (e.g., Alberta Merged Wetland Inventory);
- From a field monitoring perspective, collect information on the five main classes of wetlands from the Alberta Wetland Classification System (AWCS): bog, fen, marsh, swamp, and shallow-open water. However, the most common classes of wetlands should be prioritised for monitoring;
- From a wetland inventory perspective, at a minimum include all five AWCS classes of wetlands in a wetland inventory. It is critical to map the location and extent of wetlands in the region and track change over time;
- Monitor both natural and restored/reclaimed/created wetlands, with natural wetlands being a priority;
- Provide baseline information so that change in wetland condition can be detected;
- Measure the cumulative effects of anthropogenic activities on wetlands;
- Measure the effects of specific anthropogenic activities (e.g., dewatering from oil sands activities) on wetlands;
- Attribute observed change to particular causes (anthropogenic and natural);
- Tease apart the effect of natural factors (e.g., natural climate variability and wildfire) from the effect of land use activities;
- Trigger decision-making that is scale appropriate, i.e., regional or sector/site-specific, when change is observed;

- Inform regulations and planning policies, and support the broader needs of society. Key policies to support are the Alberta Wetland Policy, the Land-use Framework, and the *Environmental Protection and Enhancement Act* (*EPEA*);
- Monitor wetland condition at the regional and operator/site-specific scales. Maximize alignment between the indicators collected at the regional and operator/site-specific scales; and
- Drive reduction of cumulative effects from all types of human activity.

2.2.2. Inputs Relevant to a Field Monitoring Program

Question 1- Wetlands Classification

This question's main objective was to determine which wetlands should be part of the monitoring program. As a guide for the question, we provided the names and definitions of the five wetland classes in the AWCS: bog, fen, marsh, swamp, and shallow-open water. More specifically, participants were asked to 1) identify which wetlands they interact with most frequently, 2) identify which wetlands should be part of the monitoring program, and 3) specify which one(s) should be prioritised.

Question: What classes of wetlands does your sector interact with? Which wetland classes should the Monitoring Program assess?

There was an overarching agreement among participants that, although dependent on the specific monitoring objectives, all five classes of wetlands are important and should be monitored. However, several participants expressed that:

- If the monitoring objective was to determine the condition of wetlands in the Oil Sands region, the most common classes should be prioritized. In the boreal wetlands, peatlands (bog, fen, and swamp) are the most common wetland classes and should be prioritized over other classes, if necessary. At a minimum, fens and bogs should be monitored.
- If the monitoring objective was to detect change caused by anthropogenic activities, then classes that are most sensitive to those activities should be prioritized over others, if necessary:
    - For example, if the monitoring program aims to detect the effect of anthropogenic activities such as dewatering on wetlands, fens are sensitive to hydrological changes and should be monitored.
    - As another example, if the monitoring program aims to detect the effect of atmospheric depositions on wetlands, bogs should be monitored because they are sensitive to this type of anthropogenic stressor.
- If the program aims to assess the condition of wetlands that are important to maintaining species biodiversity, then classes that provide key wildlife habitats should be included:
    - For example, several participants mentioned the importance of monitoring waterfowl and endangered species (e.g., Yellow Rail) habitats; therefore, these habitats, including fens, bogs, swamps, and shallow-open water wetlands, should be monitored.
- Some participants said that certain wetland classes are not currently well monitored and that information about these wetlands is scarce. Thus, the monitoring program should prioritize these classes over others.
- Some participants felt that both lentic and lotic wetland ecosystems should be monitored.
- Fens were mentioned as an important wetland class to monitor in the region as Fen cover is a proposed Tier 2 Aquatic Habitat indicator in the Biodiversity Monitoring Framework for the Lower Athabasca Region.

A majority of participants suggested that wetland types and hydroperiods (permanent, intermittent, seasonally saturated, temporary, and ephemeral) should be monitored:

- While the five AWCS classes provide a good foundation for categorizing wetlands, the variability of wetlands is such that there are still many wetland types and hydroperiods that are not explicitly covered by these five classes. These should be monitored.
- Small wetlands tend to be more sensitive to stressors and thus finer resolution monitoring is needed.
- Small and/or intermittent wetlands are important for the biodiversity of the region and should be included in the monitoring program.

Most participants agreed that the monitoring program should align well with the AWCS (i.e., if this program will have more than the five AWCS classes then these classes could be rolled up into the AWCS):

- Participants suggested that using the AWCS-based classification would allow the monitoring program to better align with existing provincial and federal legislation, policies, strategies, and frameworks (e.g., the Alberta Wetland Policy).
- In addition, using the AWCS would better support existing provincial and federal wetland inventories and the Canadian Wetland Classification System.

Some discussions centered on monitoring on- and off-lease wetlands. To comply with *EPEA* regulations and approval conditions, mining and oil companies have monitoring programs in place for on-lease wetlands:

- It was strongly articulated that public funds should not be spent on monitoring wetlands that are responsibility of industry.
- The majority of participants stressed that although industry is responsible for monitoring wetlands affected by their activities, their monitoring program(s) should align and be well integrated with a publicly-sponsored regional wetland monitoring program.

Question 2 - Natural and Created Wetlands

The Alberta Wetland Policy states that when avoiding or minimizing impacts to wetlands is unachievable, wetlands must be replaced with constructed wetlands of comparable functional value. Industrial activities in the Oil Sands region are subject to mandatory requirements to control and address impacts to wetlands. In the Oil Sands region, where numerous anthropogenic activities occur, restored, reclaimed, and created wetlands are anticipated to be a growing component of the landscape. The main objective of this question was to determine if participants envisioned that the program should monitor natural and restored/reclaimed/created wetlands and, if so, which one(s) should be prioritized.

Question: Should the monitoring program assess natural and restored/reclaimed/created wetlands?

Although participant responses varied, most agreed that the program should monitor both natural and constructed wetlands:

- Overall, there was an agreement that natural and restored/reclaimed/created wetlands are critical features within the Oil Sands landscape.
- Participants stressed that this monitoring program should align with the Alberta Wetland Policy, which is applicable to natural and restored/reclaimed/created wetlands.
- When the participants were further asked to prioritize, monitoring natural wetlands was preferred over monitoring restored/reclaimed/created wetlands.

One of the key management needs identified and shared by a number of participants was to quantify net gains and losses of wetlands in the landscape. Many participants strongly stated that public funds should not be spent on monitoring restored/reclaimed/created wetlands, and that this should be the responsibility of industry. As constructed wetlands are a form of wetland mitigation practice, these wetlands are permitted and regulated under the *EPEA* and the Alberta Wetland Policy, and thus the permittee needs to fulfill various monitoring obligations. As such, monitoring of these wetlands should be financed by the permittee. Through the permitting process, the Government of Alberta has the means to gather monitoring information on these wetlands. It was suggested that this new monitoring program should focus resources on wetlands that are not responsibility of industry. Thus, in this context, the new monitoring program should not monitor restored/reclaimed/created wetlands. However, some participants have stated that constructed wetlands must be considered when measuring gains in wetlands and that including restored/reclaimed/created wetlands would provide information to measure the efficacy of the Alberta Wetland Policy.

Question 3 – Sector-Specific Wetland Management and Monitoring Needs

One of the goals of the monitoring program is to provide information to support the management and monitoring needs of the diverse stakeholders in the Oil Sands region. This question's objective was to support the development of the potential scope, goals, and specific monitoring questions of the monitoring program. More specifically, the question aimed to 1) determine the range of management and monitoring needs of the various stakeholders, and 2) determine which of those needs were shared among stakeholders.

Question: What are the wetland management and monitoring needs of your sector?

Management and monitoring needs were diverse, but there was a theme of long-term, province-wide monitoring at a variety of spatial scales to detect changes in wetland condition:

- A majority of participants highlighted the need for a province-wide monitoring program:
  - Although participants recognized the pressing need to monitor at the regional and site/sector-specific scale, many stressed that this program must be developed and applied at the provincial level in the near future.
  - Many participants suggested that the Oil Sands region may not be the appropriate regional boundary for the program. To facilitate management decision-making, the program should operate within the boundaries of the Land-use Framework planning regions.
- Most participants mentioned the importance of implementing a monitoring program that operates over many decades, and ideally in perpetuity. According to the participants, long-term monitoring should allow the collection of all necessary information on the natural variability of wetlands in the Oil Sands region, and hence better detection of wetland change over time.
- Participants were interested in understanding the general and overall condition of wetlands in the Oil Sands region. However, some participants provided a counter-argument that a large volume of data has been already collected for certain classes of wetlands in the Oil Sands region and that there is no need to collect further baseline information about these wetland classes.

A majority of participants discussed the importance of understanding the cumulative effects of anthropogenic activities on the condition of wetlands in the region:

- Changes in wetland condition that were of interest to the participants included: wetland extent, classification (e.g., classes, types, hydroperiod), surface water quality and quantity, groundwater quality and quantity, and biota (e.g., waterfowl, rare species).

A majority of the discussions focused on the need to determine the effect of specific anthropogenic activities on the condition of wetlands:

- Most participants mentioned that it is imperative for the program to provide the ability to determine the effect of specific anthropogenic activities (e.g., dewatering from mining activities) on the condition of wetlands adjacent to or in areas where anthropogenic activities occur.
- Although participants' concerns were centered on the effect of oil sands activities (mining and *in situ*), many of them highlighted the importance of determining the effect of other anthropogenic activities including forestry, agriculture, recreation, urban development, and infrastructure development (e.g., roads).

A few participants mentioned the need to collect data to develop and support indices of biodiversity, integrity, intactness, and species (e.g., fish) sustainability, and data for modeling purposes (e.g., hydrologic models including surface water and groundwater, species abundance, and occurrence models).

Feedback from the participants highlighted a series of needs related to the main environmental legislation, policies, strategies and frameworks governing the management of wetlands in Alberta:

- The monitoring program should support and inform decision-making related to the management of wetlands.
- The most commonly mentioned policy was the Alberta Wetland Policy. To support the mandate and the efficacy of the Alberta Wetland Policy, wetland experts and stakeholders discussed several critical monitoring needs:
    - Develop a wetland inventory that maps and tracks changes over time in wetlands, e.g., the location, extent, abundance and classification of wetlands in the Oil Sands region and throughout Alberta.
    - Collect information in the field and via remote sensing on the condition of wetlands, including information on their hydrology, water quality, and biodiversity.
    - Track the condition of wetlands over time to detect change and understand the drivers of observed change(s), which may include direct anthropogenic activities, land use changes, and/or climate change.
- Needs related to the support of the *EPEA* came second after those related to the Alberta Wetland Policy. To support the mandate of the *EPEA*, which aims to protect air, land, and water in site-specific settings, the participants mentioned several monitoring needs:
    - Understand the connection between the implementation of the Alberta Wetland Policy and *EPEA*. Some participants mentioned that the link between the mandate of the *EPEA* and that of the Alberta Wetland Policy must be clearly defined as it is currently only implicitly stated.
    - Understand the natural range of variability of wetlands within or adjacent to the area of oil sands activity and within the *in situ* area. At present, this lack of information prevents determination of whether the observed changes in wetland conditions should be attributed to industrial activities or to natural factors such as climate variability.
    - Track the condition of reclaimed, restored, and created wetlands over time to assess how those ecosystems compare to natural wetlands. Some participants highlighted the importance of monitoring the long-term trajectory of reclaimed/restored/created wetlands. However, some participants provided the counter-argument that this type of monitoring is industry's responsibility and that public funds should not be used.

- Needs related to the Land-use Framework were also part of the discourse. In relation to wetlands, the Land-use Framework addresses cumulative effects management, environmental sustainability, and biodiversity and land management. Needs discussed by the participants included:
    - Developing a wetland inventory that maps and tracks changes over time in wetlands, including information on the location, extent, abundance and classification of wetlands in the Oil Sands region and throughout Alberta. For example, under the Biodiversity Management Framework's Aquatic Habitat Pyramid, Aquatic native cover is a proposed Tier 1 indicator and Fen cover is a proposed Tier 2 indicator in the Lower Athabasca Region.

In addition to the Alberta Wetland Policy, *EPEA*, and Land-use Framework, some participants mentioned needs related to the following international, federal, and provincial policies: the Ramsar Convention, the Water for Life Strategy, the *Water Act*, the *Public Lands Act*, the *Fish and Wildlife Act*, the upcoming Biodiversity Policy, and climate change policies.

Question 4 - Monitoring Program Approaches

Both the federal and provincial governments recognize the importance of maintaining the function and value of wetlands. While the Alberta Wetland Policy moved from an acreage-based to a function-based approach to managing wetlands, the Federal Policy on Wetland Conservation has among its goals to ensure no net loss of wetland functions and services. The objective of this question was to investigate the monitoring approach that participants envisioned for the program. More precisely, this question aimed to determine the monitoring approach that best aligned with stakeholders' management and monitoring needs. To facilitate the discussion, participants were provided with four examples of monitoring approaches: 1) an acreage-based approach[2]; 2) a physically-, chemically-, and biologically-based approach; 3) a function-based approach[3]; and 4) a service-based approach[4].

<u>Question</u>: What is the best approach for the Monitoring Program?

Most participants expressed that the program should encompass all four suggested monitoring approaches:

- Participants mentioned that function- and service-based approaches should be derived from an approach combining the acreage, physical, chemical, and biological approaches.

A majority of participants discussed the critical need to monitor wetland extent and repeatedly highlighted the importance of an acreage-based approach:

- At the regional and provincial scale, a wetland inventory is needed to better determine the location, extent, and abundance of wetlands (by classes, types, and hydroperiod).
- An acreage-approach is an efficient way to monitor the long-term condition of wetlands as it allows assessing changes in wetland extent and abundance over space and time.

[2] Assess the status and trend of wetland area.

[3] Assess the status and trend of wetland function. Wetland function is defined as the process or series of natural processes occurring within a wetland, these include the storage of water, transformation of nutrients, and habitat for biotic communities.

[4] Assess the status and trend of wetland functions that are of importance to society. These include protection against floods, water purification, amenities, and recreational opportunities.

- Information collected through an acreage-approach is generally simple to interpret. These data can then be used to inform land use decisions and resource management actions, as well as inform the general public.
- The acreage-based approach relies heavily on remote sensing tools and techniques:
    - While an acreage-based approach should primarily be remote sensing-based, participants stressed that it should be complemented with field data validation.
    - Several participants highlighted the importance of these data being georeferenced to allow querying, overlaying, and analysis with other data sets.
    - Participants stated that these data must be publically available.
    - Several wetland experts and stakeholders expressed hope that Alberta will push the level of remote sensing-based wetland monitoring to create a world-class wetland inventory.

The participants generally agreed that an acreage-based approach should be supplemented with physical, chemical, and biological approaches because:

- The acreage-based approach relies heavily on field sampling techniques.
- The acreage-based approach would provide critical information on wetland condition. This information is needed to support the main environmental legislations, policies, regulatory strategies, and frameworks related to wetland management in the province.
- Although it would be ideal to measure a wide variety of physical, chemical, and biological characteristics, there was agreement among participants that the monitoring program must remain cost-effective.
- The participants mentioned numerous parameters and indicator variables, including surface and groundwater quality and quantity, invertebrates, vegetation and waterfowl abundance, presence of rare species, and species of cultural importance:
    - Several participants stressed that if such a monitoring program were expanded from the Oil Sands region to the whole province, the appropriate indicators might vary by region.

Most participants viewed the function- and service- based approaches as extensions of the other two approaches and therefore did not propose them as primary approaches for the monitoring program:

- A number of participants mentioned that a function-based approach can be derived from the data collected via acreage-based, physical, chemical, and biological monitoring approaches whereas a service-based approach can be developed from a function-based approach.
- Multiple participants felt that although the assessment and management goals of the Alberta Wetland Policy are function-based, a function-based approach should not be the main approach for the program:
    - Participants stressed that it would be challenging to get metrics that are useful to a wide variety of stakeholders when using this approach.
    - Function- and service-based metrics were said to sometimes be challenging to measure, analyse, interpret and communicate.

Question 5 - Monitoring Program Accomplishments

The goal of this question was to understand how stakeholders defined a successful monitoring program. Specifically, the question aimed to: 1) identify the components (e.g., scope of the program, monitoring objectives, questions, variables to monitor) of a successful monitoring program that are relevant to their needs, and 2) discuss the monitoring and management framework within which the program should be set.

<u>Question</u>: What should a good wetland monitoring program accomplish? What should it allow stakeholders to do?

The feedback from the participants was mostly centered on one theme: the main objective of the monitoring program should be to detect wetland change and determine its cause(s):

- Numerous participants mentioned that to be able to detect change that is attributable to anthropogenic activities the monitoring program must first determine the natural range of spatiotemporal variability in wetlands:
    - They stressed the importance of considering the dynamic nature of wetlands and of adjusting monitoring frequency and effort to ensure the capture of their seasonal and interannual variation. Participants highlighted that sampling frequency will determine whether change in wetland condition can be detected.
- Participants discussed the importance of understanding the direct and indirect effects of anthropogenic activities on the condition of wetlands.
- Participants interested in a monitoring program that aims to detect wetland change suggested many potential response variables including the extent of wetlands, hydrology (sediment or soil saturation, water depth), vegetation composition, contaminants, water quality, etc.
- Participants interested in a monitoring program that aims to attribute wetland change to a cause suggested various potential drivers and stressors variables to monitor, including those related to the cumulative effects of anthropogenic activities, oil sands mining, oil and gas *in situ* activities, forestry, agriculture, urban development, effects of climate change, and other natural factors such as fire and insect outbreaks.

Participants suggested that the monitoring program should detect wetland change at the regional and operator/site-specific scales:

- Most participants highlighted the need to monitor wetlands to detect changes that are caused by the cumulative effects of anthropogenic activities at the regional scale.
- Most participants mentioned the need to monitor the effect of specific anthropogenic activities (e.g., dewatering from mining activities and atmospheric deposition from mining activities).

Many participants stressed that although the monitoring program should operate on two different spatial scales, data collected at the regional and operator/site-specific scales should be comparable (e.g., using the same field sampling protocols) and scalable:

- For stakeholders that manage wetlands at the operator/site-specific scale, the technical requirement was for a regional wetland monitoring program that develops information on regional and natural variability to facilitate understanding of remediation targets. For these stakeholders, regional data will inform the development of triggers to determine when a change directly associated with development is significant enough to require intervention.
- Regarding the design of the regional program, some participants mentioned that the endpoints need to be consistent between the regional and operator/site-specific monitoring scales, so that information needs at the operator/site-specific scale can be met, and reference conditions and natural variability can be interpreted.

Many participants discussed the importance of monitoring the effect of climate change on wetlands:

- Participants stressed the importance of understanding the effect of climate change on the condition of wetlands:

    - A sampling design appropriate (e.g., frequency and scale of sampling, etc.) to determining the effect of climate variability and teasing it apart from the effects of land use activities was suggested.
- One participant mentioned that the monitoring program should help to determine how wetlands can alleviate climate change through carbon sequestration.
- One participant discussed the need to monitor the integrity and health of reclaimed wetlands over time in the face of climate change projections.

Some participants mentioned the importance of monitoring reclaimed/restored wetland sites over a long time period to determine if they function as expected and if their functions are equivalent to those of reference natural wetlands:

- Assessing the condition of reclaimed wetlands over the long term would also provide information to assess the efficacy of the Alberta Wetland Policy.

Participants discussed the importance of the monitoring program generating and being supported by scientific research.

- A few participants highlighted the importance of scientific research to improve and support the monitoring program. For example, the development of indicators and metrics to detect and measure the potential effect of anthropogenic activities should be supported by science.
- Other participants suggested that once change in the condition of wetlands has been observed through monitoring, it should trigger specific and targeted research questions that would provide information to support decision-making.
- Some participants suggested that while it is known that wetlands in the Oil Sands region and throughout Alberta provide ecological goods and services, there is a need to better understand and quantify the monetary value of wetlands in a changing landscape.

Many participants discussed the principles that should guide the monitoring program. They stressed that the wetland monitoring program should:

- Be scientifically-credible and transparent with protocols and sampling methods freely accessible and available to use.
- Adopt a standardized approach similar to the Alberta Wetland Rapid Evaluation Tool - Actual. Sampling designs, protocols, and analysis should be consistent across sampling location and time.
- Produce open-access data and information with shared ownership.
    - The data should be freely and easily accessible and usable.
    - The geographic location (exact latitude and longitude) of the sampling sites should be available and shared.
- Avoid duplication of existing efforts and be cost effective.
- Provide data that are relevant to informing adaptive management decisions, supporting regulations (e.g., *EPEA* and the *Water Act*) and planning policies (e.g., Water for Life, the Wetland Policy, and the Land-Use Framework), and support the broader needs of society.

Question 6 - Unknowns in Wetland Condition

The main objective of this question was to ensure that the stakeholders had an additional opportunity to express any further needs in relation to a wetland monitoring program. In addition, the question aimed to identify outstanding information needed from a monitoring program that would better support the needs of the stakeholders. More specifically, this question aimed to identify 1) key

unknowns related to the condition of wetlands in the Oil Sands region, and 2) the data and tools that could be developed to better support the needs of the stakeholders.

<u>Question</u>: What are the unknowns in wetland condition?

The unknowns in wetland condition were grouped into four main categories: 1) the effect of climate change on wetlands, 2) baseline information on wetland hydrology (e.g., groundwater, hydrological connectivity), 3) the cumulative effect of stressors on wetlands, and 4) wetland net loss and gain across the landscape.

The influence of climate variability on wetlands was the most discussed unknown. Participants highlighted the importance of understanding its effect on wetlands and teasing apart its effect from that of land use activities:

- Participants discussed how climate change could influence the condition of wetlands, specifically hydrology, water and soil quality, and gas emission properties.

Numerous participants mentioned the lack of information about the processes influencing wetland conditions:

- The relationships between climate as a driver of hydrology and hydrology as a driver of wetland abiotic (e.g., water quality) and biotic (e.g., vegetation) conditions are not well understood.
    - A number of participants mentioned the lack of information about the groundwater–surface water interactions in wetlands in the Oil Sands region.
    - Some participants stressed that most wetland monitoring programs focus on surface water quality and quantity, and less on groundwater quality, quantity and connectivity patterns.
    - Monitoring and mapping the wetland-groundwater interactions throughout the region was said to be important for 1) understanding the impacts of pollutants, 2) understanding the effect of anthropogenic activities, 3) predicting the effect of climate change, and 4) developing models of water supply and wetland ecosystem services.

A few participants stressed that there are many unknowns related to measuring the cumulative effects of anthropogenic activities on wetlands:

- Indicators of wetland condition need to be identified and selected, and proper monitoring methodologies developed.

Another unknown discussed by the participants is directly related to wetland loss:

- Participants mentioned that existing wetland inventories for Alberta do not allow the tracking of wetland loss over time.
    - A few participants mentioned that the lack of this information prevents understanding of how wetland loss influences species and biodiversity losses.
- Another unknown referred to the historical status of wetland abundance and location.
    - In order to understand the present abundance and location of wetlands, several wetland experts and stakeholders suggested using historical aerial images to develop maps.
- Some participants suggested that monitoring wetland loss is important so that the efficacy of the Alberta Wetland Policy, i.e. avoidance of wetlands, can be assessed.

2.2.3. Inputs Relevant and Specific to Wetland Mapping

Wetland experts and stakeholders across sectors have clearly expressed their need for a detailed wetland inventory:

- A majority of participants mentioned that existing wetland inventories do not adequately support their monitoring and management needs.
- Many participants mentioned that, at minimum, there is a need to monitor wetlands by AWCS classes and track their location, abundance, and extent over time.

The wetland inventory should provide resolution as fine as is economically and technologically possible:

- If a finer resolution is applied, then types and hydroperiods should be an extension of the major wetland classes being monitored.
- The wetland inventory should be able to map small wetlands (< 1 hectare).

Participants also discussed specific application of the available and existing remote sensing technologies that can support the monitoring program:

- One wetland expert stressed that fusing existing remote sensing technologies and techniques, such as using optical, LiDAR, and RADAR data together, would be useful for capturing the annual and interannual variability of wetland extent. Application of optical data will allow mapping of land surface properties, including different vegetation communities. The LiDAR data enables mapping of land surface structure, including terrain properties (e.g., lowlands vs. uplands, open waterbody boundaries, etc.) and vegetation structure (e.g., vegetation structure in swamps). Application of RADAR data has a strong advantage in monitoring as the data are weather independent and thus can capture images for various stages of the water cycle (from snow melt to freeze up). The different wavelengths/bands can capture different classes and types of wetlands. For example, Synthetic Aperture Radar X-band and C-band do well with marshes and low swamps, while L-band works well with swamps with high vegetation. It was noted that there will be a new satellite system launched in 2018 that could capture Oil Sands imagery over a weekly time frame.

3. Survey: Prioritizing Management and Monitoring Needs

Using the outcomes of the interviews, we transformed the various needs expressed by the participants into a list of potential program goals and monitoring objectives. In the second phase of the stakeholder engagement process, we asked wetland experts and stakeholders to prioritize the potential program goals and monitoring objectives using an online survey approach.

The goal of the online survey was to formulate the feedback provided by the wetland experts and stakeholders into a well-articulated framework for the wetland monitoring program that reflects the majority of needs. The aim of the online survey was to:

1) Identify which monitoring objectives were prioritized by the participants;
2) Analyse the priorities; and
3) Identify the potential scope and objectives of the monitoring program.

This section details the following about the online survey:

- Limitations to the survey;
- The process for developing and circulating the survey; and
- Results and outcomes from the survey.

The full survey and the results obtained through the survey are available in the Supplemental Information Report and are synthesized in the sections below. In addition, the context and main goal of each question is provided. Although worded or presented differently, some questions were asked several times during the survey to 1) test if the answers of the participants were consistent as the survey unfolded, and 2) provide multiple opportunities to the participants to re-visit or further explain their opinions. The survey was developed in a manner that ensured that the results from these repeated questions were comparable. To avoid redundancy, these questions will not be discussed in detail in the following sections.

3.1. Limitations

The online survey collected quantitative and qualitative (via comment sections) information. While the qualitative and quantitative input captured during the survey was important and represented a variety of perspectives, there were limitations to drawing conclusions from the survey including:

- Participation in the survey was voluntary. Although numerous people from various stakeholder groups (sectors) were invited to participate, not everyone did so. Some sectors were represented by more participants than others.
- The relationship between the number of participants and responses received for each question was not one-to-one. Some participants did not answer all questions, some only provided comments without answering the questions, and others answered each question in addition to providing comments.
- While this summary may be helpful in understanding participants' perspectives, the answers may not be exhaustive. Rather, the outcomes described in this summary illustrate only those comments received during the survey, and give a general indication of the views expressed.

3.2. Building the Survey and Selecting the Participants

The online survey was built using *Survey Monkey* and was launched on February 10, 2016. Survey invitations were sent to wetland experts and stakeholders, including those who ultimately participated

in the interview process and others who were unable to participate. Two reminder emails were sent on February 17 and 18, 2016. The survey closed on February 22, 2016.

The survey was composed of 17 questions (see full online survey in the Supplemental Information Report). For questions 3, 10, and 17, a comment section was included to allow respondents to explain and/or add nuances to their answers. The first two questions were meant to gather demographic information about the respondents.

In addition, to allow analysis of the quantitative data collected through the survey, all comments received were transcribed into electronic form prior to the qualitative analysis. Analysis involved reading the text, then sorting and combining comments to identify patterns.

3.3. Analysis of the Survey Results

3.3.1. Question 1 – Participant Affiliation

The survey was sent to 89 representatives of various sectors (i.e., provincial and federal government, academia, industry, NGOs, environmental consulting, environmental monitoring, and others). From the 89 solicited representatives, 50 people responded and completed the survey entirely or partially. The objective of this question was to determine each respondent's sector affiliation.

Q1: Which sector are you affiliated with?

Of the 50 respondents, 13 represented the federal or provincial government, 11 were from academia, 9 from industry (forestry and oil and gas), 6 from NGOs, 4 from environmental consulting, 4 from environmental monitoring (Figure 2, Table 1 in the Supplemental Information Report), and 3 from other sectors.

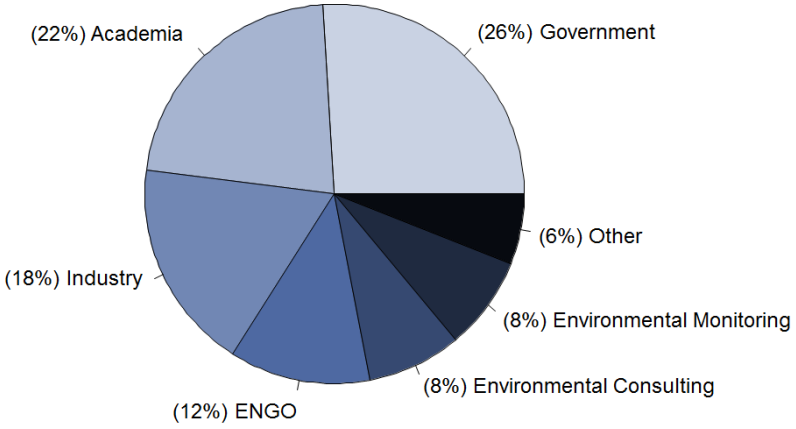

Figure 2. Proportion of participants from each sector.

3.3.2. Question 2 – Participant Professional Background

The objective of this question was to determine the range of expertise of the respondents. Knowing their background provided further perspective when interpreting the results.

Q2: What is your professional background?

In total, 50 participants from different professional backgrounds answered this question (Figure 3, Table 2 in the Supplemental Information Report). Most identified themselves as having experience in more

than one discipline. For example, the majority (62%) of participants had an ecology background. More than half (52%) had experience related to environmental monitoring, while 46% had a background in biology, and 44% in natural resource management.

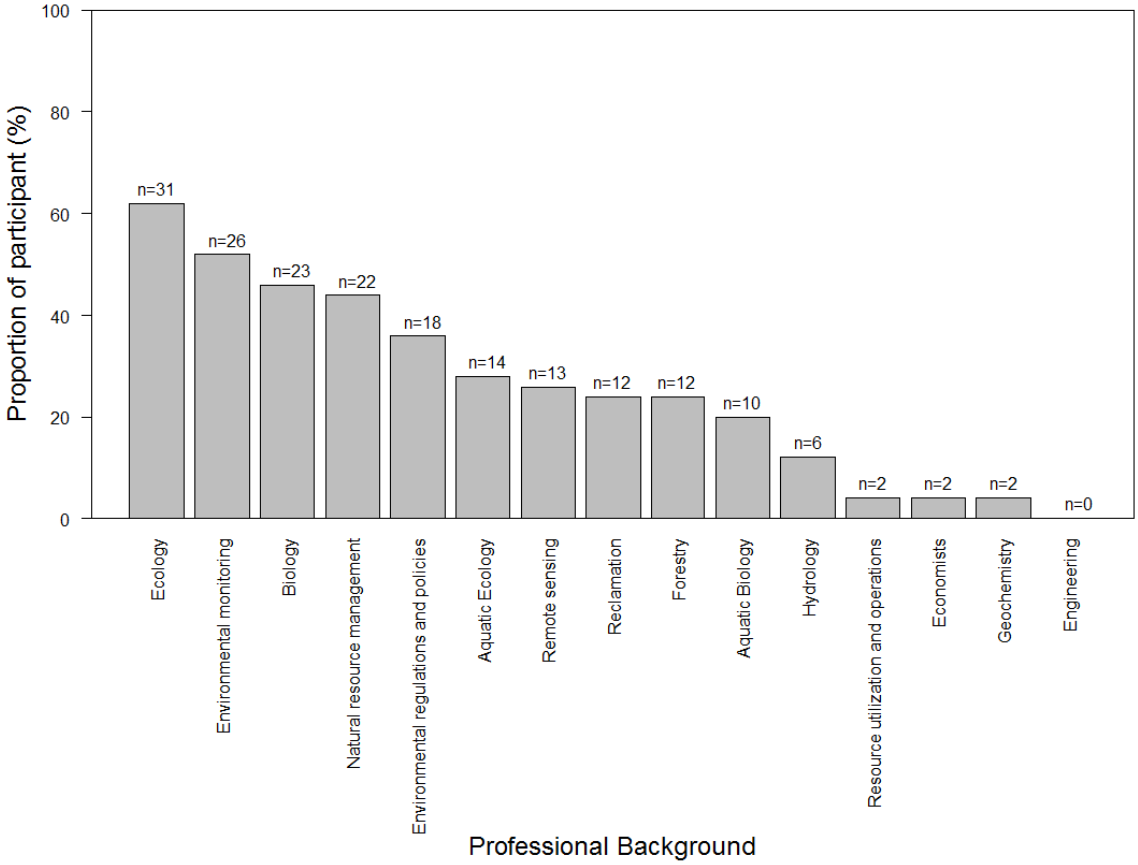

Figure 3. Percentage of participants with experience in a given discipline. Most participants identified themselves as having experience and expertise in more than one discipline; n = number of participants.

3.3.3. Question 3 – Monitoring Objectives[5]

During the interviews, the stakeholders discussed their various management and monitoring needs. Following the interviews, we summarized, synthesized, and transformed those needs into a series of potential monitoring objectives. One of the goals of the survey was to identify which of these potential monitoring objectives should be prioritized.

Q3: Using the interviews, we identified five potential objectives for the Wetland Monitoring Program. Prioritize the following monitoring objectives (1–5, where 1 is the highest priority).

The five monitoring objectives were:

- Collect baseline information to determine the spatial and temporal variability of wetlands;

[5] Questions 10 and 12 were equivalent to Question 3. These three questions aimed to determine which monitoring objectives were prioritized by the respondents. Using different words or a different style of question, Question 3 was asked a second and third time through Questions 11 and 12 to test if the answers of the participants remained consistent as the survey unfolded (Tables 8 and 9 in the Supplemental Information Report).

- Detect wetland change over time (trend monitoring);
- Determine the causes (anthropogenic) of the observed change;
- Determine the effect of climate change on wetlands; and
- Track the long-term trajectory of reclaimed/restored wetlands.

Analysis independent of sector

After averaging the respective scores among all participants (independent of sector), the monitoring objectives were prioritized in the following order (Figure 4, Table 3 in the Supplemental Information Report):

1) Collect baseline information to determine the spatial and temporal variability of wetlands (Baseline);
2) Detect wetland change over time (Detect change);
3) Determine the anthropogenic causes of the observed change (Attribute cause);
4) Determine the effect of climate change on wetlands (Effect of climate); and
5) Track the long-term trajectory of reclaimed wetlands (Reclaimed wetland).

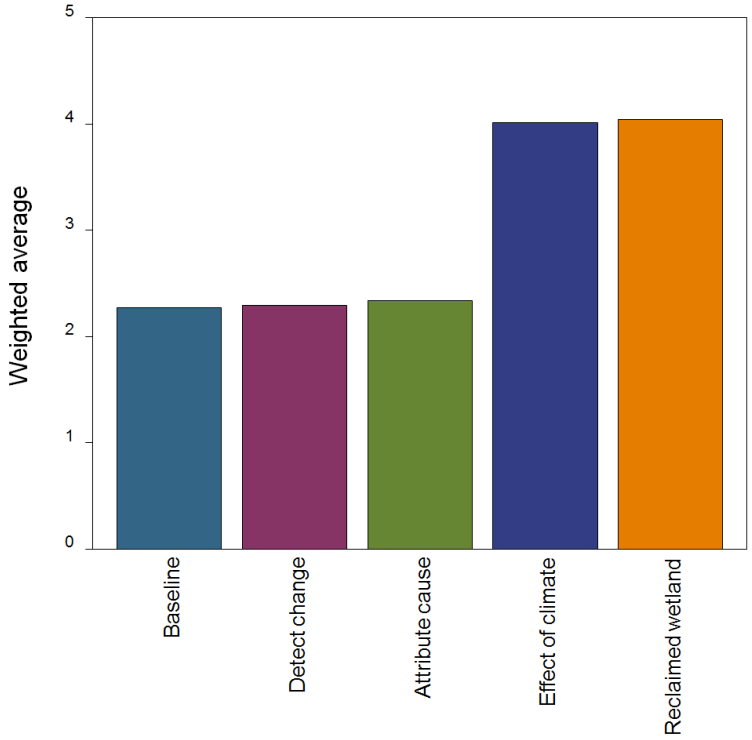

Figure 4. Average score for each of the potential monitoring objectives (regardless of sector). Objectives with the lowest weighted average score were of higher priority. The average was weighted by the number of participants in each sector so that each sector had equal weight.

For Question 3, participants had the opportunity to provide comments[6]. The comments from all respondents were summarized and synthesized. The main take-home messages associated with this question were as follows:

- The top three monitoring objectives are inherently linked and perceived as a logically ordered process.
    - Baseline information is used to define and characterize the natural range of variability of wetlands.
    - Change is detected by comparing the conditions of a specific wetland to the baseline conditions.
    - Causes are investigated only when change is detected.
- Although important to measure as a covariate, climate change should not be the main focus of the monitoring program.
- *Tracking the long-term trajectory of reclaimed wetlands* is important, but should not be a priority for the monitoring program at this time. This objective should be part of the monitoring program in the near future when/if resources are available.

Analysis among sectors

The information provided in Figure 4 can be further examined from a sector-level perspective.

Aside from academia, all other sectors had the following as their first three priorities:

- *Collect baseline information to determine the spatial and temporal variability of wetlands;*
- *Detect wetland change over time (trend monitoring); and*
- *Determine the causes (anthropogenic) of the observed change* (Figure 5, Table 3 in the Supplemental Information Report).

Although selected as their three main priorities, the order of priority of these three objectives varied among sectors. Academia was the only sector that had *Track the long-term trajectory of reclaimed wetlands* as one of its top three priorities (Figure1 in the Supplemental Information Report).

[6] Questions 10 and 12 were equivalent to Question 3; therefore, comments provided for Question 11 and 12 were included in the synthesis of the comments for Question 3.

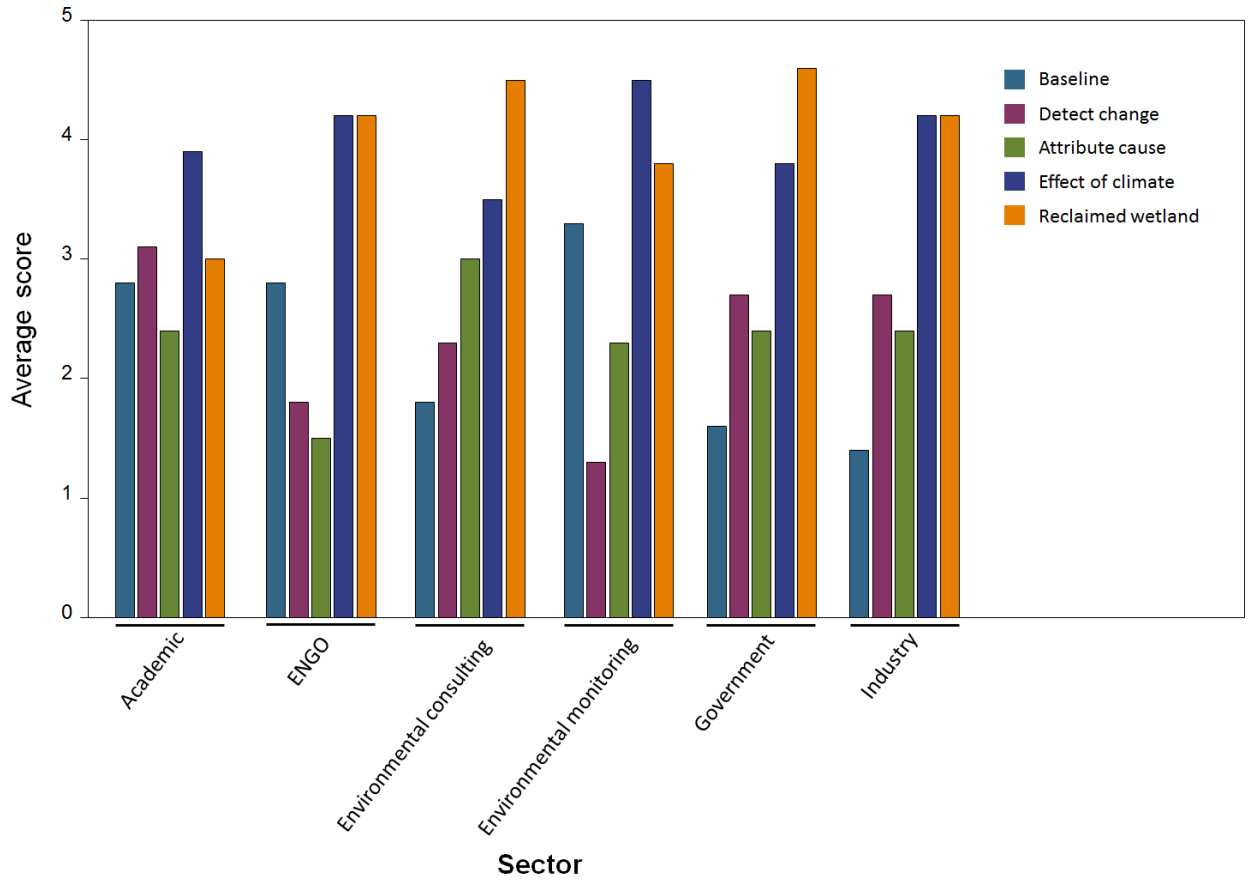

Figure 5. Average score for each potential monitoring objective per sector. Objectives with lower average score were identified as higher priority.

3.3.4. Questions 5 to 9 and 16 – Wetland characteristics (condition)

Selecting variables to monitor depends on the specific monitoring objectives. For example, if the objective is to determine if nutrient enrichment from agricultural activities changes the condition of wetlands, variables that are good indicators (anticipatory and diagnostic) of this stressor should be selected and monitored. During the interviews, numerous participants highlighted that in addition to variables that are good indicators of specific stressors, the monitoring program should also provide information about variables that are of interest to the stakeholders. One of the goals of the survey was to understand which broad categories of wetland characteristics (condition) were important to the respondents for each of the monitoring objectives.

Q5: If the wetland monitoring program collects baseline data to characterize the natural variability of wetlands, prioritize the following monitoring questions.

Q6: If the wetland monitoring program tracks the status and trend of wetlands over time, prioritize the following monitoring questions.

Q7: If the wetland monitoring program assesses the effects of anthropogenic activities on wetlands, prioritize the following monitoring questions.

Q8: If the wetland monitoring program assesses the effects of climate change on wetlands, prioritize the following monitoring questions.

Q9: If the wetland monitoring program tracks the long-term trajectory of reclaimed wetlands, prioritize the following monitoring questions.

For each potential monitoring objective, the prospective wetland characteristics to prioritize were:

- Wetland inventory (extent and topography)[7];
- Water physicochemistry;
- Sediment physicochemistry;
- Fauna and flora;
- Wetland saturation;
- Wetland groundwater; and
- Biogeochemical cycling.

For the monitoring objectives *Collect baseline information to determine the spatial and temporal variability of wetlands*, *Detect wetland change over time (trend monitoring)*, and *Determine the causes (anthropogenic) of the observed change*, the wetland characteristics were prioritized in the following order (most important to least important) (Figure 6, Tables 4 and 5 in the Supplemental Information Report):

1) Wetland inventory;
2) Fauna and flora;
3) Water physicochemistry;
4) Wetland saturation;
5) Wetland groundwater;
6) Sediment physicochemistry; and
7) Biogeochemical cycling.

For the *Determine the effect of climate change on wetlands* monitoring objective, the respondents prioritized the needs as follows (highest to lowest priority):

1) Collection of information about the distribution, extent and abundance of wetlands in the landscape;
2) Monitoring the effects of climate change on fauna and flora;
3) Monitoring the effects of climate change on wetland saturation;
4) Monitoring wetland groundwater;
5) Monitoring wetland biogeochemical cycling;
6) Monitoring wetland water physicochemsitry; and
7) Monitoring sediment physicochemsitry.

Under the monitoring objective that aims to *Track the long-term trajectory of reclaimed wetlands* the respondents prioritized the needs as follows (highest to lowest priority):

[7] For the objective *Track the long-term trajectory of reclaimed wetlands, the* category "Wetland inventory" was divided into two sub-categories being *spatial distribution of wetlands* and *abundance of wetland*s.

1. Monitor the spatial distribution of reclaimed wetlands;
2. Monitor reclaimed wetland fauna and flora;
3. Monitor reclaimed wetland abundance in the landscape;
4. Monitor reclaimed water physicochemsitry;
5. Monitor reclaimed wetland saturation;
6. Monitor reclaimed wetland sediment physicochemistry;
7. Monitor reclaimed wetland groundwater;
8. Monitor reclaimed wetland biogeochemical cycling.

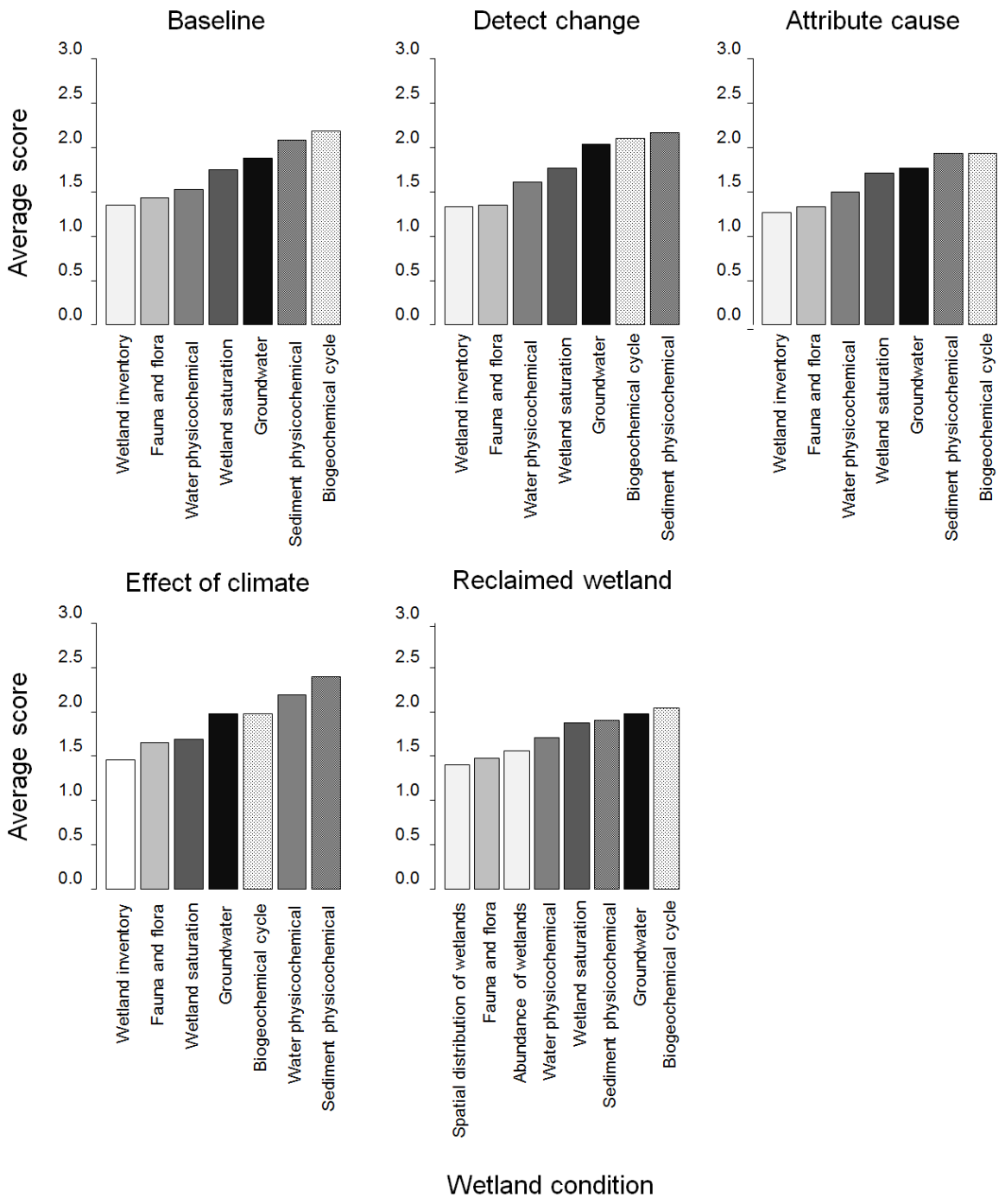

Figure 6. Average score of each potential wetland characteristic to monitor. Characteristics with lower average scores were given higher priority. The average score was weighted by the number of participants in each sector so that each sector had equal weight. Baseline = Collect baseline information to determine the spatial and temporal variability of wetlands; Detect change = Detect wetland change over time (trend monitoring); Attribute cause = Determine the causes (anthropogenic) of the observed change; Effect of climate = Determine the effect of climate variability on wetlands; and Reclaimed wetland = Track the long-term trajectory of reclaimed wetlands.

Q16: Which type(s) of wetland conditions and functions interest you or your sector?

The goal of Question 16 was to determine which broad categories of wetland conditions, independent of monitoring objectives, were important to the respondents. A majority of respondents (85%) were interested in having a wetland inventory that provides information about the location and extent of wetlands in the landscape (Figure 7, Tables 6 and 7 in the Supplemental Information Report). Fauna and flora was selected by 79% of respondents as a wetland condition of interest for their sector. Hydrology came in third position, selected by 75% of respondents. Contaminants were selected by 62% of respondents, while 53% selected water and sediment physicochemistry. Information about the condition of the biogeochemical cycle was selected by 38% of respondents. A total of 19% of the respondents mentioned that "other" conditions were important and provided their suggestions in a comment section.

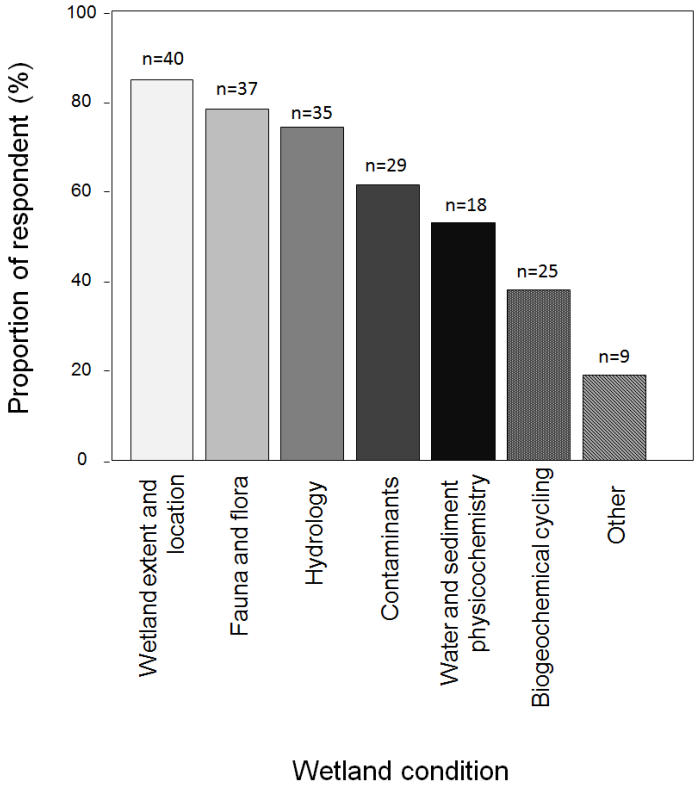

Figure 7. Summary of the categories of wetland conditions, which were important to respondents independently of the identified monitoring objectives.

Attached to Question 16, respondents had the opportunity to provide comments, but only a few (n = 9) did so. The comments were collected, summarized and synthesized. The comments were:

- Fauna and flora should be monitored and include species of cultural importance such as caribou and moose.
    - By contrast, one respondent suggested that vegetation communities and not wildlife should be monitored.
- Wetland functions and services should be monitored, specifically:

    - Surface water and groundwater interactions and wetland complexes connected through these interactions.
    - Storage capacity and monitoring of buffers.
    - Human use/recreation.
- Water quality and quantity and impacts to vegetation should be monitored.
    - One respondent suggested that water chemistry but not sediment chemistry should be monitored.

3.3.5. Question 13, 14, 15 & 17 – Additional Input

The goal of questions 13, 14 and 15 was to clarify and validate particular opinions expressed by the participants during the interview process. Question 17 was the final question of the survey, and provided a third comment opportunity.

Q13: Should the Wetland Monitoring Program address: What is the toxicity level of harvestable/consumable resources, such as fish, plants, and mammals?

Respondents' responses (n = 44) were divided on this question (Figure 8**Error! Reference source not found.**). A total of 55% of respondents suggested that the program should monitor the toxicity level of harvestable/consumable resources, while 45% did not see this as a priority.

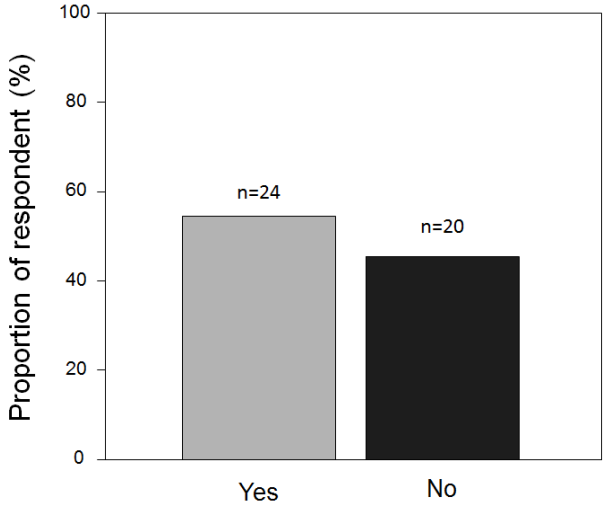

Figure 8. Responses to the question: Should the Program monitor the toxicity level of harvestable/consumable resources?

Q14: If the wetland monitoring program tracks the status and trend of wetlands, should the Program seek to identify the cause of the observed changes?

There was strong agreement with this statement (n = 46) among the stakeholders (Figure 9). A total of 85% of the respondents agreed that the monitoring program should identify the cause(s) of observed change, whereas 15% preferred a monitoring program that does not seek this information.

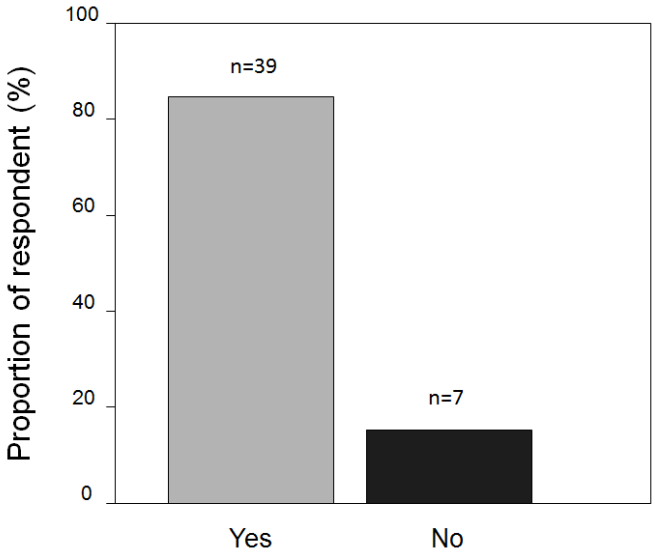

Figure 9. Responses to the question: Should the program seek to identify the cause of the observed changes?

Q15: If the wetland monitoring program assesses the effects of anthropogenic activity on wetlands, should the Program be designed to differentiate between the effects of anthropogenic activity types (e.g., agriculture, forestry, mining, and urbanization) on wetlands?

There was strong (n = 48) agreement among the respondents (Figure 10). 90% agreed that the monitoring program should assess and differentiate the effects of numerous anthropogenic activities, while 10% (n = 5) disagreed.

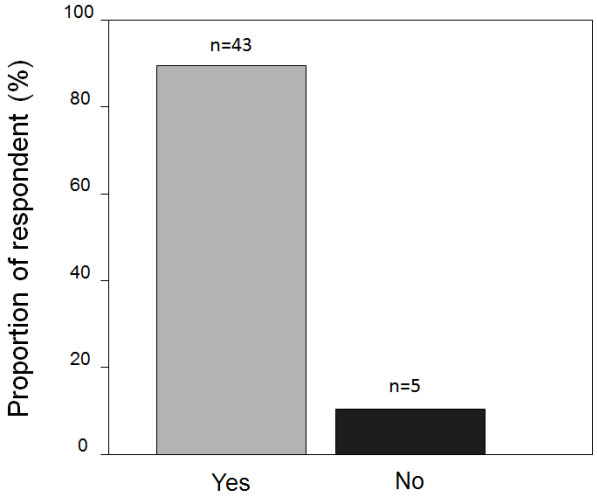

Figure 10. The response of respondents to the question: Should the program be designed to differentiate between the effects of anthropogenic activity types on wetlands?

Q17: Additional Comments

At the end of the survey, the respondents had the opportunity to provide comments (Question 17). A total of 18 respondents provided their commentary input. The comments were collected, summarized, and synthesized. The comments were various and covered numerous topics:

- There is a pressing need to refine the existing wetland layers: need to have the finest spatial resolution possible and be available province wide.
- There is not enough time or funding to assess the impacts of all anthropogenic activities on all the different classes of wetlands. The program must focus on objectives that relate to the oil sands, especially in the most common classes of wetlands and/or in those that are rarest or most valuable.
- The linkage between monitoring and compensation for wetland loss should be made explicit. There is a great need for quantifying the degrees of success achieved in reclamation efforts.
- Fish and wildlife toxicity should be monitored, but not by means of the wetland monitoring program budget.
- Some of the respondents suggested that the monitoring program should be integrated and supported by a management framework. The respondents suggested that the monitoring program should:
    - Investigate the cause of change only when necessary (i.e., when the condition of a wetland significantly changes).
        - One respondent stressed that differentiating among the impacts of different anthropogenic activities will only be important if there will be a management response (e.g., will the sector causing the impact be expected to compensate for the damage, mitigate impacts, etc.?).
    - Facilitate and trigger decision-making.
    - Attribute and mitigate the effect of anthropogenic activities.
    - Drive reduction of cumulative effects from all types of human activity.

4. Workshop: Seeking Collective Agreement on the Program's Foundation and Framework

As the third phase of the stakeholder engagement process, AEMERA and the ABMI co-hosted a two-day workshop at the University of Alberta on March 16 and 17, 2016 (Figure 1). The workshop was designed to bring wetland experts and stakeholders together to openly discuss areas of commonality and trade-offs, with a view to building a program that supports the collective needs of key stakeholders operating and managing wetlands in the region.

This section provides the following:

- Day 1 (March 16th) overview:
    - An overview of the goals and process for Day 1
    - Outcomes and key messages from Day 1
- Day 2 (March 17th) overview:
    - An overview of the goals and process for Day 2
    - Outcomes and key messages from Day 2

All workshop documents (e.g., invitations, agendas, handouts, and participant list) and PowerPoint presentations are available in the Supplemental Information Report.

4.1. Day 1 Overview and Outcomes

4.1.1. Goals and Objectives

The aim was to discuss the knowledge gained in this project and to conclude with a collective vision that articulated the goals, objectives, and questions for the Wetland Monitoring Program. This collective vision would set the scope for discussions on March 17th and the future design of the monitoring strategy.

Specifically, the desired outcomes for Day 1 were to:

1) Provide a summary of the work completed to date (e.g., the review of existing wetland monitoring programs and remote sensing capabilities, the review of the main anthropogenic activities occurring in the Oil Sands region, etc.)
2) Report back on key themes, needs, and results from the first two steps of the stakeholder-consultation process (i.e., interviews and survey with wetland experts and stakeholders).
3) Discuss the foundational monitoring goals, objectives, and questions for the wetland monitoring program in the Oil Sands region.
4) Identify additional needs, concepts, and recommendations to be incorporated into the final report.

4.1.2. Participants and Workshop Facilitation

All wetland experts and stakeholders invited to participate in the interviews and/or survey were also invited to participate in Day 1 of the workshop. Additionally, invitations were extended to people recommended by the invited wetland experts and stakeholders. In total, e-mail invitations to Day 1 (see Day 1 workshop Invitation in the Supplemental Information Report) were extended to 95 people. A total of 45 people attended Day 1 of the workshop, with four of the participants attending remotely via *Join-Me* (see Day 1 Final Participant List in the Supplemental Information Report).

When signing into the workshop, each participant was asked to self-identify with one of five sectors (i.e., government, industry, academia, environmental consulting and monitoring, and NGO) by placing a

colored dot on their name tag. The self-identification dots were used in the afternoon sessions to facilitate creation of mixed-sector discussion groups.

Two facilitators from Urban Systems were retained by ABMI to assist in the planning and facilitation of Day 1 of the workshop. They focused on keeping the presentations and sessions on time, notetaking through the discussion sessions, and providing a post-workshop Summary Report (see Urban Systems Report in the Supplemental Information Report).

4.1.3. Agenda: Overview and Sessions

Day 1 of the workshop was held from 8:30 am to 4:30 pm, March 16th in the Wild Rose Room in Lister Conference Centre at the University of Alberta. At sign in, each participant was provided with a workshop packet (see Day 1 Handouts in the Supplemental Information Report). The packet folder included:

1. An agenda and project overview;
2. A summary table of wetland field monitoring programs;
3. An overview of wetland remote sensing techniques;
4. A glossary of wetland monitoring terms;
5. A workshop feedback form.

To meet the objectives of the Workshop, there were two parts to the Workshop:

- Part 1 – Presentations
- Part 2 – Round Table Discussions

Part 1 – Presentations

The morning of the workshop focused on information output through presentations on each portion of the work being completed for the overall project. The purpose of the presentations was to provide common ground information to all of the workshop participants in order to facilitate the afternoon discussions and be a basis to the outcomes for the final report. Each presenter was given approximately 20 minutes to present with time for 1–3 questions.

Ted Nason (AEMERA) – *Workshop Overview and Introductions*

As this wetland monitoring program project's lead from AEMERA and co-chair of the Joint Oil Sands Monitoring Program's Biodiversity Component Advisory Committee, Ted Nason introduced the scope and goals of the workshop and gave context to the key functions of a monitoring program intended to measure, assess, and inform on environmental conditions. He described the history of the project from its conception in spring 2014 with JOSM to its initiation in fall 2015. The key goals of the project are to: 1) develop a scientifically robust, integrated, and relevant wetland monitoring program, 2) address locally and regionally relevant questions related to wetland health and sustainability in the Oils Sands region, and 3) provide information that will allow managers to distinguish between natural and anthropogenic change in wetlands. The full presentation is available in the Supplemental Information Report.

Jan Ciborowski (University of Windsor) – *Summary of CEMA's Recommendations for a Wetland Monitoring Program*

Jan Ciborowski led the Cumulative Environmental Management Association's (CEMA) 2012 project to develop a regional monitoring program to assess the effects of oil sands development on wetland

habitat and ecosystems and comply with *EPEA* approval conditions. This work provides a foundation for the current project. Specifically, Jan was asked to provide a summary of CEMA's findings and recommendations with a focus on how to monitor oil sands development effects on wetlands and how to apply the reference condition approach to reclamation areas. Jan stressed the importance of setting the monitoring questions and selecting the variables and indicators to support those questions. Through the presentation, Jan described and recommended using a reference condition approach to distinguish degraded wetlands from reference wetlands. He specifically recommended a reference-degraded continuum approach, as it can determine the extent of degradation from reference conditions based on use and application of bioindicators. The full presentation is available in the Supplemental Information Report.

Danielle Cobbaert (Alberta Energy Regulator) – *EPEA Oil Sands Mines Wetland Monitoring Program Development*

One of the identified objectives of the wetland monitoring program is to support the needs of the *EPEA* approval conditions. To identify the key compliance and regulatory requirements for a regional wetland monitoring program, Danielle Cobbaert presented on Alberta Energy Regulator (AER) wetland monitoring needs. Danielle described the AER's needs for a wetland monitoring program and an interpretation of the *EPEA* approval conditions. At present, AER is working with AEMERA and industry to develop a monitoring program to fulfill the *EPEA* approval conditions. The program focusses on the sector and operator levels to implement a tiered, effect-based approach to monitor the effects of hydrologic alteration and aerial deposition on the ecological condition of dominant wetland classes adjacent to mine lease boundaries. Future work will focus on hosting a state-of-knowledge workshop and developing field and remote sensing study approaches. The full presentation is available in the Supplemental Information Report.

Jim Herbers (ABMI) – *Project Scope and Existing Management Framework*

As the ABMI's Information Centre Director and a co-lead on the project's technical team, Jim Herbers provided an in-depth look at the project scope and context within the management framework, including the federal and provincial policies' monitoring needs. This project represents the start of long-term monitoring of cumulative effects at the regional scale, stressor-response monitoring at the sector scale, and consistency with site-level monitoring initiatives. It is set within the needs of Alberta's many policies, strategies, and legislation related to wetlands. Meeting the needs of the Alberta Wetland Policy, Land-use Framework, and *Environmental Protection and Enhancement Act* will act as an umbrella to capture the needs of other components of the management framework. The presentation further detailed how those needs could be met by the Wetland Monitoring Program.

Due to a shortage of time, Jim was unable to complete the entire presentation. The sections that were not presented described the work being conducted by Fiera Biological Consulting to evaluate existing field wetland monitoring programs, and remote sensing to identify the gaps and commonalities for integration with the new program. The full presentation is available in the Supplemental Information Report.

Brian Eaton (Alberta Innovates Technology Futures) – *Stressors and Indicators of Wetland Change*

As an aquatic ecologist focused on ecological conservation at AITF, Brian Eaton joined the project team to identify drivers and response variables for wetlands that could be identified and included in a regional wetland monitoring program. This work builds on the work of CEMA and extends its scope to the larger

oil sands region. Through the presentation, Brian described the diversity and complexity of variables and the major human footprint types in the region. There were several recommendations for the program: develop monitoring and management frameworks; select two sets of wetland for status and trend assessments and for stress gradient calibration; establish a standardized sampling approach; and calibrate potential indicators to stressors. The full presentation is available in the Supplemental Information Report.

Jim Schieck (ABMI) – *Monitoring Design to Assess Cumulative Effects and Stress Response Relationships*

As the ABMI's Science Centre Co-Director and a co-lead on the project's technical team, Jim Schieck presented on considering two types of sampling design: stressor-response and cumulative effects. As each design has slightly different goals, integration must be forced and considered from the beginning. It is critical to choose variables to maximize signal/noise ratio, use covariates and repeated measures design to control noise, and optimize the cost/benefit ratio. Jim further stressed that a pilot study is key to the integration and establishment of the new monitoring program. For efficiency, it is critical to test the program assumptions and design on a small scale before rolling out a fully operational program. The full presentation is available in the Supplemental Information Report.

MC Roy (ABMI) – *Uncovering Monitoring Objectives through a Stakeholder Consultation Process*

As the ABMI's wetland ecologist and project co-lead, MC Roy presented the outcomes from the review of the management framework needs, interviews, and the online survey to set the stage for the rest of the workshop. The key messages from those activities led to the proposed monitoring framework along with monitoring goals and objectives, which were presented for workshop discussion. Two goals were developed and proposed based on the stakeholder engagement and consultation process:

- Goal 1: Monitor the health of wetlands in the Oil Sands region and measure the cumulative effects of natural and anthropogenic factors on wetlands.
- Goal 2: Detect change in wetlands that can be attributed to specific anthropogenic activities (sector, operator/site-specific).

The two goals would be set at different scales and use different strategies to ultimately detect wetland change over time and inform and support monitoring and management needs. The full presentation is available in the Supplemental Information Report.

Part 2 – Round Table Discussions

The afternoon of the workshop was separated into three sessions: *Defining Success*, *Delving into the Proposed Monitoring Objectives*, and *Exploring the Development Priorities*. The afternoon sessions were designed to be more interactive for the participants. Each session was built around answering different questions for the Project team and further developing the proposed monitoring framework presented by MC Roy.

Session 1 – *Defining Success*

For the first session, participants were dispersed into four tables with each table representing a mixed-sector discussion group based on the dot color of their name tag. This was done to help ensure a diversity of perspectives were present at each table. At each of the tables, a facilitator took notes, and a presenter was identified for later reporting of key discussion points. This session focused on thinking about and discussing the following question:

What does a successful, scientifically robust, integrated, and relevant wetland monitoring program look like?

This discussion was followed by reporting back to the larger group. This allowed participants to hear what other groups had said and if needed modify reported answers.

Session 2 – *Delving into the Proposed Monitoring Objectives*

The second session was designed using a "World Café" facilitation approach. The participants were divided into three different tables to ensure mixed-sector discussion groups. The purpose of the session was to discuss how the presented monitoring framework sets the foundation for the program's success, as defined in Session 1. Each table had a facilitator to guide the discussion and take notes. In fifteen-minute intervals, participants were then asked to rotate to each table and participate in conversations about the corresponding topic. The table facilitator presented the notes back to the entire group in order to capture the commonalities and unique ideas raised by each group. Each table focused on one of the following questions:

- Table 1: What management and monitoring needs will be met by the proposed monitoring goals and objectives?
- Table 2: What are the strengths and limitations of the proposed monitoring goals and objectives?
- Table 3: What monitoring questions and indicator types should be addressed under the proposed monitoring goals and objectives?

Session 3 - *Exploring the Development Priorities*

The final session for the day revolved around how suite of monitoring related environmental legislations and policies could be developed and which of the components should be prioritized. Participants self-divided into five groups and were asked to create a "Mind Map" of how they envisioned a framework for the wetland monitoring program should come together. Each group was provided with a 6 × 4-foot piece of paper on the wall with a starter card deck and blank cards. The deck was composed of words comprising elements of a wetland monitoring program. The terms included the following categories: impacts (e.g., mining, agriculture, and cumulative effect), wetland classes (e.g., fen and marsh), actions (e.g., sampling, reporting, and trigger), legislations and policies (e.g., Alberta Wetland Policy), monitoring objectives (e.g., detect wetland change), and additional words (e.g., climate, soil, reclaimed wetlands, and tiered) (see Session 3 Handout in the Supplemental Information Report).

After 45 minutes, all five groups were asked to walk through their "Mind Map" and explain their reasoning behind it with one of the project team members.

4.1.4. Day 1 Outcomes

Session 1 – Defining Success

From the discussions in Session 1 – *Defining Success*, seven themes emerged across the four groups. Collectively, the workshop participants viewed a successful wetland monitoring program to be: relevant, specific, cost-effective, scalable, adaptive, timely, and accessible. The data that make up these themes have been summarized in Table 2 (Defining Success).

Relevant

One of the key features of a monitoring program is relevance. A wetland monitoring program should be both ecologically and policy relevant.

Ecologically, the temporal and spatial scales of monitoring must match the scale at which wetland processes and functions occur, and the sampling frequency must be sufficient to detect change. Adaptive management decisions can only be made if the change (positive or negative) is captured. If the sampling frequency is not appropriate, then the monitoring program will not achieve its goals.

The goals, questions, and direction of the monitoring program must be relevant to supporting the cross-disciplinary management and policy needs of the stakeholders. It is important that the monitoring program should be guided by and designed to support the planning, policy, legislative, and legal needs of the stakeholders. The policies mentioned included the Land-use Framework, the Alberta Wetland Policy, the *EPEA*, and environmental impact assessments.

Clear and Specific

Clarity and specificity were discussed across groups. It was important to the participants that the goals and questions of the monitoring program were clear and specific. One area in which participants recommended specificity was on foundational definitions, such as *significant adverse effect*, *cumulative effect*, *baseline*, and *natural variability*. Additionally, the process to address the goals and questions needs to be clear and specific. The methods, protocols, data storage, QA/QC, and analysis processes should be clear, specific, transparent, and accessible to the stakeholders and users.

Cost-Effective

Resources are limited. The monitoring program needs to recognize this limitation and strive to be both efficient and effective. During the development process, it was important to identify and develop the partnership to leverage existing resources and programs. The new monitoring should not duplicate existing efforts. Additionally, the scope of the monitoring program should be realistic. The number of sampling locations and types of indicators should be considered for their cost-effectiveness. Many participants discussed how infeasible it is to monitor everything due to limited resources. Monitoring the most relevant indicators to detect changes was important to all the discussion groups.

Scalable

The Wetland Monitoring Program needs to be scalable, whether it is implemented in different regions of Alberta or across different sectors of the Oils Sands region. The core of the program should be modular and integrated, and able to be tailored and expanded to meet specific monitoring needs or questions. The program should also be able to sample across different temporal scales

Adaptive

Across the discussion groups, participants discussed how a monitoring program must be dynamic and able to adapt to change. It was recommended that the program include management and monitoring responses. These responses would be triggered when certain thresholds of change are crossed. It was also recommended that the program be developed with a broad set of indicators at the core, and that a more extensive set of indicators could be monitored in specific situations.

Timely

For a monitoring program to succeed, the monitoring data must be available to help inform decision-making. To support decision-making, the wetland monitoring program needs to be effective and provide data, results, evaluation, and dissemination of information in a timely manner. The data need to be easily accessible and available to the stakeholders, with clear and timely communication to the appropriate stakeholders when negative change is detected.

Accessible

For the participants, it was important that the monitoring program be developed to address their needs. For those needs to be met, the data must be useful and available to all stakeholders. Thus, it is critical that the data are provided freely and in a timely manner. It was recommended that this could be done through an open-architecture database. The development of the database infrastructure should be considered as part of sampling protocol development. In addition to freely-available QA/QC data, the monitoring program should provide initial analysis and communication of the results. Overall, it was repeatedly stressed that stakeholders want to know the results of monitoring and have unrestricted access to the data.

Table 2. Outcomes from Session 1 – *Defining Success.* Summary of characteristics for a successful wetland monitoring program as identified by participants.

Defining Success of a Monitoring Program			
Relevant	• Ecologically relevant • Clear big picture • Data kept in context • Realistic • Cross-disciplinary • Supports compliance • Goals are important to stakeholders • Support the Land-use Framework and Alberta Wetland Policy • Linked to the *EPEA* and Environmental Impact Assessments • Linked to regulation and legal requirements, and policy and planning needs	**Adaptive**	• Thresholds • Built-in management and monitoring responses • Broader and shallower set of indicators that can be delved into • Data storage infrastructure • Accounting of existing and future cumulative effects
Clear and Specific	• Clear objectives • Questions relate to goals • Standardization in methods: field data collection, remote sensing data collection, metadata protocols, and data storage • Detailed, consistent, and clear definitions: *significant adverse effect*, *baseline*, and *sensitivity to natural variability* • Awareness of tipping points • Peer reviewed methods • Peer reviewed QA/QC • Monitors the difference between natural, anthropogenic, and natural climatic variability • Measures mitigation practices	**Scalable**	• Modular • Fits the scale and area's specific needs • Spatial and temporal scales • Tier approach
Cost-effective	• Realistic • Integrates with existing systems and programs • Non-duplicative • Coordinated	**Timely**	• Report quickly • Clear communication • Detect change as it happens • Appropriate field and remote sensing sampling frequency of data for the area of interest
Accessible	• Transparent • Allows for re-analysis of data • Meets many needs • Inclusive data	• Useful • Freely available • Open architecture • Communication strategy	

Session 2 – Delving into the Proposed Monitoring Objectives

In Session 2 – *Delving into the Proposed Monitoring Objectives*, the participants focused on answering one question at each table on the proposed monitoring objectives. From those discussions, common themes and concepts were shared among groups on how to both support and improve the proposed monitoring objectives.

Round Table 1 – Management and Monitoring Needs

The focus at Table 1 was to discuss the management and monitoring needs that would be supported by the proposed monitoring objectives. If a particular need is not supported, then participants were asked to discuss how to modify the objectives to accommodate that need.

Management Needs

- Goal 1 broadly addresses the needs of the Wetland Policy and Land-use Framework to manage cumulative effects.
- Goal 2 broadly addresses the industrial need to comply with *EPEA* approval conditions.
- Goals 1 and 2 address broader planning and policy needs, but there must still be a clear and established management framework response.
- Select indicators that are already defined within federal and provincial legislations, policies, frameworks, and guidance documents.

Monitoring Needs

- Goals 1 and 2 set up the process to focus on two areas of interest – cumulative effects at the regional scale and cause-effect at the local scale.
- The monitoring framework is being created with the forethought to use the data to allow mitigation, change in actions and behavior, and adaptive management.
- Goals 1 and 2 are framed to track both positive and negative change.

Additional Needs

- Tracking wetland mitigation trajectory is a need in the region, which seemed to be overlooked in the goals. However, a majority of participants recognized that monitoring reclaimed wetlands may be outside the scope of a regional wetland monitoring program at this time.
- Create a communication strategy to quickly and efficiently disseminate findings.

Round Table 2 – Strengths and Limitations

The focus at Table 2 was to discuss the strengths and limitations of the proposed monitoring objectives. The following are limitations to the proposed monitoring objectives, and potential ways to mitigate them.

- Limitation: The monitoring goals must be supported by specific monitoring questions and objectives.
    - Have clear and targeted questions and objectives that narrow the scope.
    - Select a focused set of indicators that will address those questions.
- Limitation: Not all wetland types are easily identifiable.
    - Select a sub-set of wetland types to monitor, like the most abundant.
    - Follow the AWCS for classifying wetland types.
- Limitation: Resources are limited, and the monitoring program needs to be cost-effective.
    - Maximize partnerships and integration with existing monitoring programs.
    - Ask specific and clear questions that have focused indicators. It is not feasible to measure everything.
    - For remote sensing, identify the appropriate level of resolution needed to support the monitoring objectives.

    - Conduct a pilot study to test and work out the kinks of the selected indicators and developed protocols at a small scale.
- Limitation: There is a lack of consistency and clarity in monitoring program definitions.
    - Establish clear operational definitions from the onset of the program.
    - Define the word "health" (as in wetland health), or replace it with "condition".
    - Be consistent with terms and definitions in all wetland monitoring program documents.
- Limitation: The quality of open source data can be challenging to ensure.
    - Develop clear and consistent standards for data collection, protocols, QA/QC, and data story.
    - Conduct transparent and repeatable analyses, supported by peer review.
- Limitation: There are concerns that data might be linked back to a specific company's liability.
    - Develop a process that triggers a management framework response.
    - Have all parties at the same table during each step of the process – monitoring, policy, and industry.
- Limitation: Attributing change (positive or negative) is challenging and takes time to assess and understand.
    - Have clear and realistic questions that are supported by an appropriate sampling design.
    - Include context and timelines for each question and objective.
    - Analyze data without bias and manipulation to find trends.
    - Establish the natural bounds of variability first.
    - Monitor a continuum of wetlands from pristine to heavily impacted.
    - Include modeling to support the program and continually test and refine the underlying assumptions.

Round Table 3 – Monitoring Questions and Indicators

The focus around Table 3 was to develop questions and recommend indicator types that should be addressed through the wetland monitoring program. Based on the discussions, the questions could be grouped into one of four categories: Management Support, Wetland Inventory, Specific Wetland Characteristics, and Specific Wetland Stressors. In developing questions, participants stressed that it is critical to identify specific monitoring questions as the proposed Goals 1 and 2 are broad. The following questions, supporting questions, and potential indicator types were generated through the discussion.

<u>Management Support</u>

- What is the condition of key indicators under environmental frameworks, e.g., Biodiversity Management Framework (BMF), and how do they change over time?
    - Monitor Fen cover (proposed Tier 2 indicator in the Lower Athabasca Region BMF) as an indicator of wetland cover through remote sensing.
- How effective are mitigation actions to reduce cumulative effects?

<u>Wetland Inventory</u>

- What defines loss of wetlands; what is a wetland?
- How much area; how many wetlands; which functional types?
    - Use remote sensing to monitor wetland extent over time and track change.
    - Be aligned with the AWCS in classifying wetland functional types.
- How do poor fen conditions change over time?

Specific Wetland Characteristics

- What is the hydrologic connectivity?
    - Monitor a combination of hydrological and ecological indicators.
    - Through remote sensing, we could monitor wetland extent over time and track the change in connectivity.
    - Clearly define the scale of interest – provincial, regional, sub-regional, sector, and/or operator.
- Where do the biota of concern occur more often?
    - Select rare wildlife and plant species as indicators.

Specific Stressors

- Is mine dewatering negatively impacting off-lease wetlands?
    - If so, what are the extent and magnitude of the impacts?
    - Monitor species composition and biodiversity
- Are emissions of airborne pollutants adversely affecting the environment and human health?
    - If so, what are the extent and magnitude of the impacts?
- What wetland types are more sensitive (responsive) to cumulative effects stemming from natural and anthropogenic factors?

Session 3 – Exploring the Development Priorities

In Session 3 – *Exploring the Development Priorities*, the participants focused on creating a "Mind Map" to visually illustrate the connections across the life cycle of a wetland monitoring program. The participants were grouped, and each group developed its own Mind Map (Figure 11, Figure 12, Figure 13, Figure 14, and Figure 15). Most significantly, the Mind Map allowed the participants to explore and discuss issues while trying to develop a wetland monitoring program for the Oil Sands region. While resulting Mind Maps were structured differently, common themes were apparent among the groups:

Management Framework and Stakeholder Needs

Each Mind Map started with establishing the monitoring objectives. The needs of federal and provincial legislations, policies, frameworks, etc. and stakeholders are directly connected to the objectives of the monitoring program. The policies specifically define the management objectives, which are translated and linked to defining the monitoring objectives and questions. All of the maps showed that the *EPEA*, Land-use Framework, and Wetland Policy should guide the monitoring program objectives. A few of the groups further included the *Species at Risk Act*, *Wildlife Act*, and the *Migratory Birds Convention Act* and supporting regulations.

In addition to guiding the monitoring objectives, each map used monitoring data to inform policy. This feedback loop is essential for stakeholders to make adaptive management decisions and fulfill the mandates of the federal and provincial environmental policies.

Wetland Classes

A key mandate for the wetland monitoring program is to monitor wetlands. In the Oil Sands region, there are five classes of wetlands. Four of the five Mind Maps included all five Alberta Wetland Classification System wetland classes (i.e., fen, bog, marsh, swamp, and shallow-open water). One group added water to the group, which could represent monitoring other surface water bodies and/or

groundwater. One group suggested focusing monitoring efforts on swamps, bogs, and fens, while another further specified only monitoring fens and bogs.

Scale

In the Oil Sands region, there are multiple spatial scales within which a monitoring program could function. There was a consensus among the Mind Maps that the monitoring program should function at the regional, sector, and site-specific levels. Provincial-level monitoring was variable among groups, and was not a priority for two.

Reference Condition

Each map specifies the importance of establishing a wetland reference condition. This can be accomplished by gathering baseline information. It is critical to have a reference condition for comparison with other wetlands and to track change and identify its drivers. Several of the Mind Maps showed that reference sites should be compared to developmental effects and drivers. One Mind Map highlighted that reference condition locations should be described as sentinel sites.

Indicators

Each of the Mind Maps included general indicator classes to monitor. The three most common were biodiversity-, hydrology-, and soil quality-related indicators. Several of the Mind Maps included sensitive wildlife species (endangered or threatened), vegetation community composition, and contaminants.

Study Design

Each of the Mind Maps included a version of a study design feedback loop or decision-making process. Across the Mind Maps there was a recognized need to develop an adaptive monitoring cycle that links to an adaptive management cycle. The adaptive monitoring cycle would consist of indicator triggers and use a tiered approach to uncover the cause of the change.

Climate Change and Reclaimed Wetlands

Climate change and reclaimed wetlands are two potential monitoring topics that have been both recommended and discussed by wetland experts and stakeholders. While recognizing that these topics are part of regional monitoring needs, the Maps consistently showed that monitoring climate change and reclaimed wetlands should not be the initial focus of the wetland monitoring program. This could be part a different phase, or a sub-component, of the program.

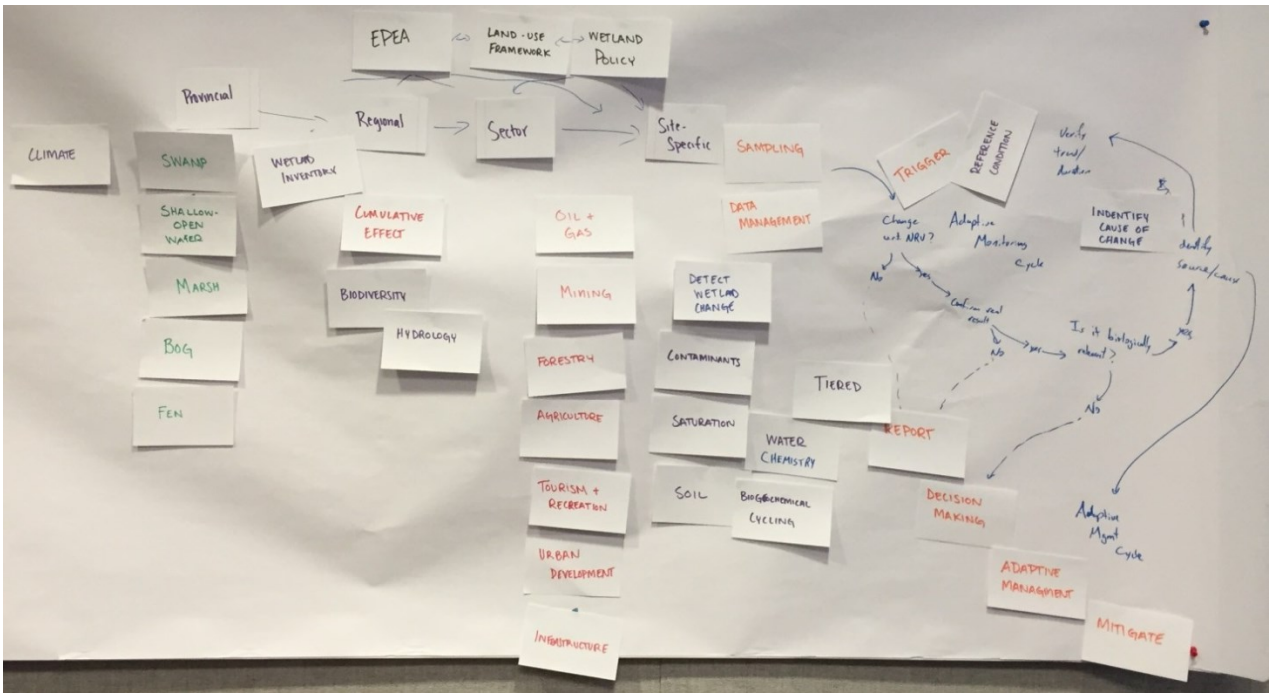

Figure 11. Group 1 Mind Map.

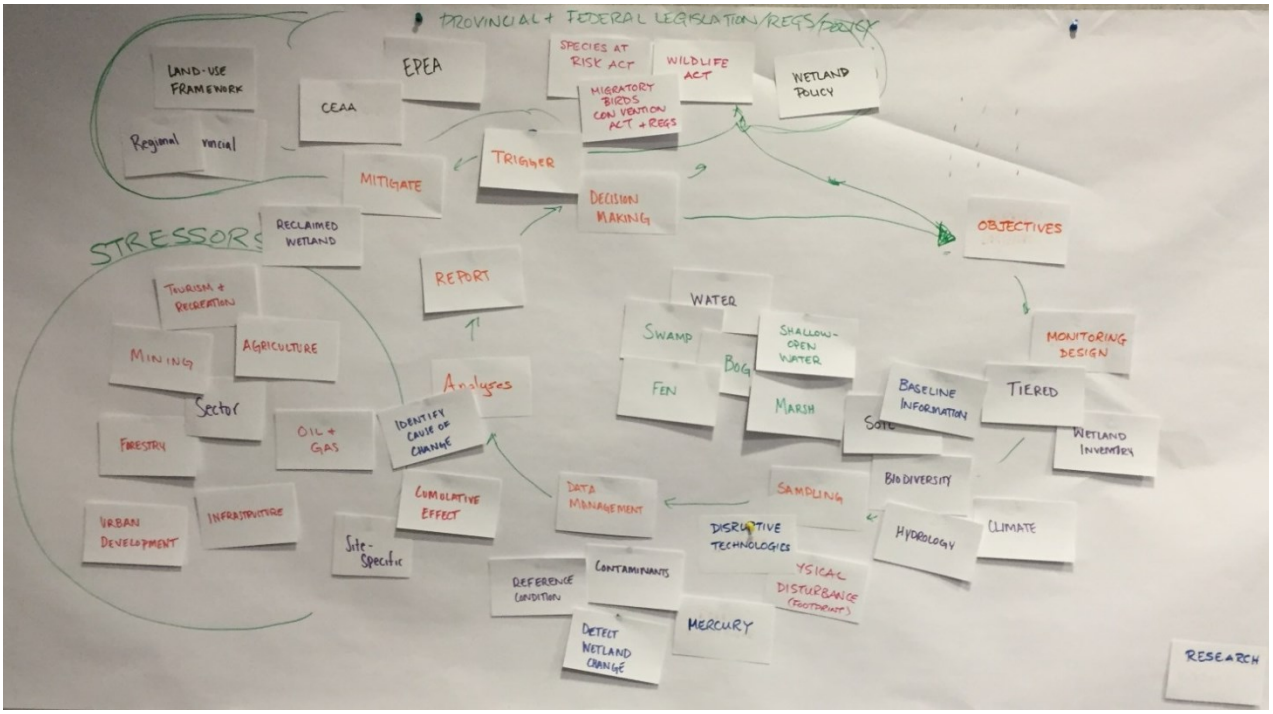

Figure 12. Group 2 Mind Map.

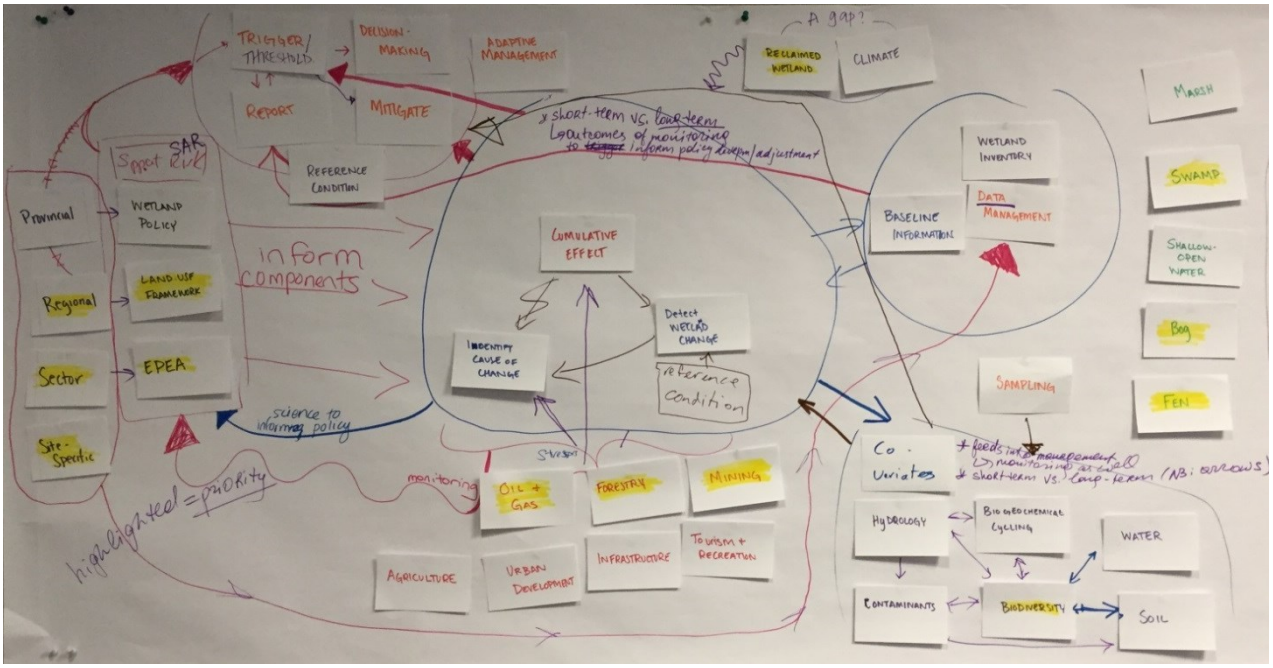

Figure 13. Group 3 Mind Map.

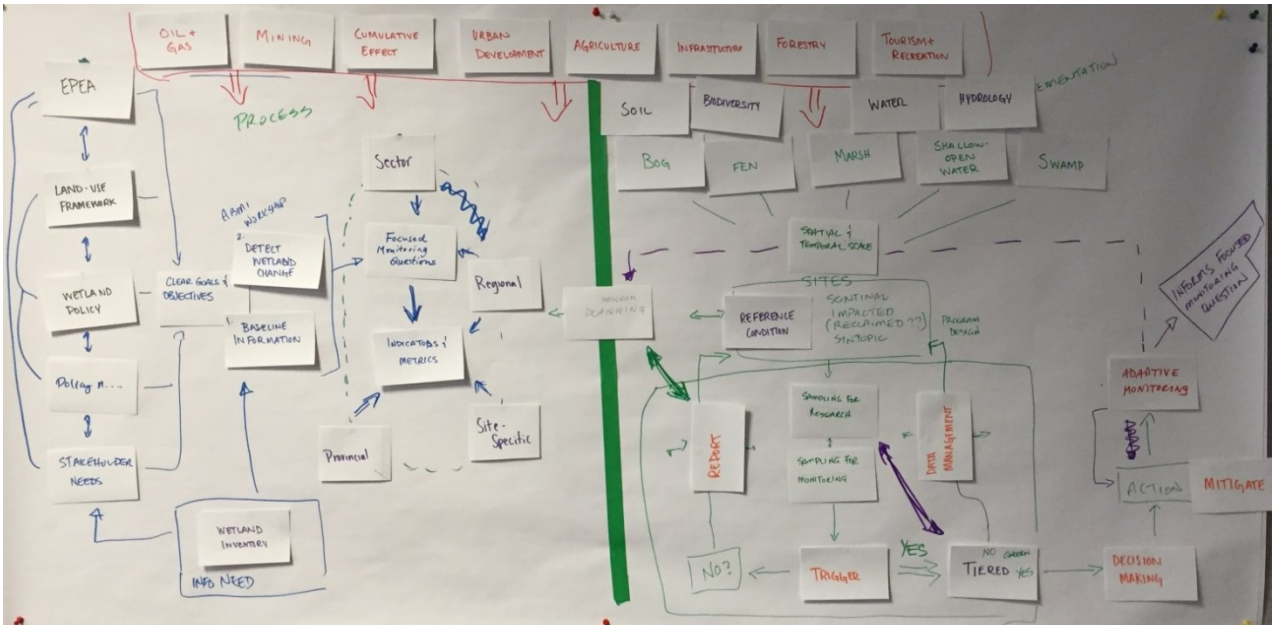

Figure 14. Group 4 Mind Map.

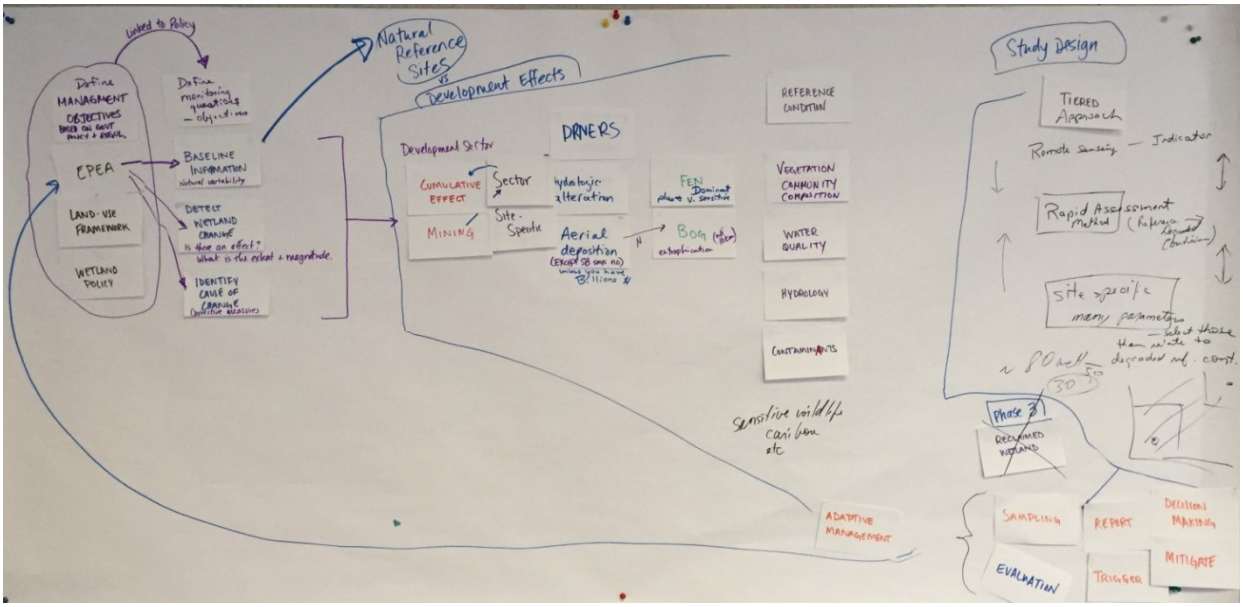

Figure 15. Group 5 Mind Map.

4.1.5. Day 1 - Conclusions

The following messages from Day 1 helped frame the discussion on Day 2 and guide project finalization:

- Broad validation of the monitoring goals and multi-scale approach (regional-cumulative effects and sector-specific).
- The Monitoring Program's goals, questions, and indicators need to extend from and support the needs of key policies and legislations, such as the *EPEA*, Land-use Framework, and Alberta Wetland Policy. Important federal policies are the *Species at Risk Act*, *Canadian Environmental Assessment Act*, and *Migratory Birds Act*. There is a need to set up a policy framework that establishes how policies can be supported by monitoring data.
- A successful monitoring program should be relevant, specific, cost-effective, scalable, adaptive, timely, and accessible.
- Efficiency and cost-effectiveness. Maximize alignment and standardization among variables, protocols, and sites.
- Potentially three levels for assessment, with good linkages among them:
    - GIS based landscape-level inventory assessment
    - Regional scale wetland assessment to understand cumulative effects
    - Intensive site-specific assessment
- "Open architecture" for data management framework and freely accessible data.
- Pilot study is necessary, but let's gets started now.
- Integrate remote-sensing with field measurements.
- With broadness, need specific and relatively manageable questions.
- Need to set a few key indicators – not worth measuring everything.
- Mitigation and post-reclamation monitoring is missing. May be out of scope or a future sub-component.

With the presentations and discussions on Day 1 of the workshop, the participants gained a deeper look into the process of developing a wetland monitoring program for the Oil Sands region. There was both

an appreciation of the complexity of the project and enthusiasm for its progress, with attention to detail, sound methods, and thorough engagement. Overall, the wetland experts and stakeholders provided broad validation of the proposed monitoring program and its goals and questions. Throughout the discussions, the wetland experts and stakeholders highlighted areas for improvement and suggestions for building a more comprehensive and integrated monitoring program that meets the diversity of management and monitoring needs.

4.2. Day 2 Overview and Outcomes

4.2.1. Goals and Objectives

March 17th (Day 2) was oriented toward a smaller, technically-focused group of wetland experts and stakeholders. Building on the outcomes of Day 1 and gathering expert recommendations, the desired outcomes for Day 2 were to:

1) Discuss key considerations to develop a monitoring strategy (objectives, questions, and indicators) to support the proposed monitoring goals;
2) Identify a pathway for integration of the monitoring objectives; and
3) Gather expert recommendations to lay the foundation for AEMERA's next phase of the project, to develop the monitoring strategy.

4.2.2. Participants and Workshop Facilitation

While the invitations for Day 1 encompassed a wide range of stakeholders, Day 2 focused on a sub-set of Day 1 participants that were sector leaders in wetland monitoring. A total of 23 invitations were extended to key representatives from each wetland-related sector (e.g., government, academia, environmental consulting, environmental monitoring, and NGO) (see Day 2 workshop Invitation in the Supplemental Information Report). There were 21 participants at Day 2 (see Day 2 Final Participant List in the Supplemental Information Report), with four attending the meeting remotely via *Join-Me*. The discussions during Day 2 were led by Ted Nason (AEMERA) and meeting coordination was supported by three ABMI personnel. There was a guiding presentation (see Day 2 Workshop Presentation in the Supplemental Information Report), but Day 2 largely focused on discussion around a single table.

4.2.3. Agenda: Overview

Day 2 of the workshop was held from 9:00 am to 12:30 pm in conference room 1-243 in the Centennial Centre for Interdisciplinary Science (see Day 2 Agenda in the Supplemental Information Report). The agenda had four topic sessions and one guiding presentation provided by Ted Nason. The full presentation is available in the Supplemental Information Report.

Session 1: Summary and Discussion of Main Observations from the Wetland Monitoring Workshop on March 16th

The focus of this session was to discuss the initial take-home messages from Day 1. The Day 2 participants further contributed to the Day 1 outcomes and revised the list based on technical feasibility. Participants were asked to focus on whether the messages were fully captured and whether there were any surprises from Day 1.

Session 2: Considerations on a Monitoring Strategy for Goal 1 and Session 3: Considerations on a Monitoring Strategy for Goal 2

In Sessions 2 and 3, participants focused on Goals 1 and 2, respectively, which were presented on Day 1. Participants discussed their ideas and opinions on the scope and direction of each goal. Through the

conversation, the participants were asked to expand the goals by introducing primary questions that should be addressed under each, and which stressors and indicators should be monitored. As participants represented field and remote sensing expertise, they were asked to provide recommendations on which indicators should be monitored via field or remote sensing means.

Session 4: Considerations on Integrating the Monitoring Goals

For the wetland monitoring program to be successful and resource-efficient, it is critical to maximize integration and alignment between Goals 1 and 2. As presented by Jim Schieck on Day 1, integration must be contemplated from the beginning of the process. In Session 4, participants were asked to weigh in on how to integrate Goals 1 and 2. To start the conversation, areas for integration included: selection of sampling sites, location of sampling sites, sampling intensity, harmonization of methods and protocols, common measurements at two scales, and wetland inventory.

4.2.4. Day 2 Outcomes

The outcomes from Day 2 largely centered on validating the proposed monitoring goals and developing foundational monitoring questions.

Goal 1

Monitor the condition of wetlands in the Oil Sands region and measure the cumulative effects of natural and anthropogenic factors on wetlands.

Goal 1 – Program and Monitoring Questions

1. Which wetlands are included and how are they defined and classified?
2. What is the baseline condition of wetlands?
3. How are wetlands changing in the region?
4. Are changes associated with any known drivers/stressors/pressures?
5. Where are wetlands changing?
6. Are some wetland classes of greater concern than others?
7. Can we detect change remotely? Can we detect change in the field? Can we detect change through modeling?

Goal 2

Detect changes in wetlands that can be associated with specific anthropogenic activities (sector, operator/site-specific) and can be differentiated from natural environmental effects.

Goal 2 – Program and Monitoring Questions

1. Is the condition of wetlands changing?
2. Can we detect change remotely? Can we detect change in the field? Can we detect change through modeling?
3. What is the cause of the change?
4. What is the extent and magnitude of the change?
5. What are the potential solutions for the change?

Recommendations for Potential Indicators

Outcomes of Day 2 provided general recommendations for indicator elements to consider.

Under Goal 1, the participants determined that it is important to monitor:

- Wetland extent, classification, and location via remote sensing monitoring. A variety of indicator variables were discussed and recommended by the participants, and should:
    1. Anticipate and diagnose cumulative effects;
    2. Support the main federal and provincial environmental policies, legislations and frameworks (e.g., Wetland Policy, Land-use Framework);
    3. Be of cultural importance (e.g., waterfowl, moose, caribou, and other species);
    4. Be common to wetland monitoring (e.g., water chemistry, vegetation composition, and climate); and
    5. Align with, complement, and support Goal 2.

Under Goal 2, the participants recognized the importance of monitoring a variety of indicator variables that:

- Primarily anticipate and diagnose specific anthropogenic activities (e.g., specific contaminants related to stressors of interest such as dibenzothiphene from upgrader stacks or boron from mine tailings).
- Are common to wetland monitoring (e.g., water chemistry, vegetation composition, and climate).
- Align with, complement, and support Goal 1 (e.g., variables to support policies and legislations and variables of cultural importance).

4.2.5. Day 2 Conclusions

Day 2 concluded with engaging conversations among the participants on the need to develop an integrated wetland monitoring program to support and inform ecologically, culturally, and economically meaningful wetland management in the Oil Sands region. While the group had differing views, job mandates, and background experiences, there was an overall sense of consensus to build a program that meets most needs of each stakeholder. From the conversations at the table, AEMERA and the ABMI came away with the following messages, which helped guide finalization of the individual project tasks:

- With minor wording adjustments, overall validation on the monitoring goals.
- Need to have a conversation around management responses and triggers. It would be beneficial for AER and AEP to be part of the process.
- Align the wetland monitoring classification with the Alberta Wetland Classification System.
- Need to have clear and consistent definitions: sampling designs, wetland classes, cumulative effects, etc.
- Need to have clear metrics, indicators, and protocols, and maximize alignment between the two goals.
- Indicators selected need to be based on a criterion that combines sensitivity and dominance of wetland classes (i.e., that captures the most abundant and most sensitive wetland classes).
- Need to collect a combination of indicators that assist with a rapid assessment approach and that are important to society and policies.

5. Summary and Conclusion

From November 2015 to April 2016, the ABMI engaged over 70 wetland experts and stakeholders through a three-phase stakeholder consultation and engagement process, which included interviews, an online survey, and a two-day workshop. The stakeholder engagement process aimed to understand the wetland management and monitoring needs in the Oil Sands region in order to develop a program to support those needs and inform management decisions. The needs and recommendations from wetland

experts and stakeholders were a vital component in developing the wetland monitoring program scope. Further, the input from the stakeholder engagement process was the foundation for the recommendations of the Final Report.

Interviews

The goal of the interviews was to understand the range of wetland management and monitoring needs by conversing with wetland experts and stakeholders representing a wide range of key sectors operating in the region. From needs expressed in the interviews, we derived potential goals and objectives for the wetland monitoring program. Although the following messages have associated caveats (see details under each question), the majority of the participants agreed that the wetland monitoring program should:

- Comprise both field and remote sensing components.
- Develop a wetland inventory and/or enhance the existing layers (e.g., Alberta Merged Wetland Inventory) to map the location and extent of wetlands in the region and track change over time.
- Collect information on the five main classes of wetlands (i.e., bog, fen, marsh, swamps, and shallow open water) as per the Alberta Wetland Classification System. However, the most common and most sensitive classes of wetlands should be prioritized for monitoring.
- Monitor both natural and restored/reclaimed/created wetlands, with natural wetlands being a priority.
- Provide baseline information so that change in wetland condition can be detected.
- Measure regional cumulative effects and sector-specific effects on wetlands.
- Be able to attribute observed change to particular causes (anthropogenic and natural).
- Trigger decision-making that is scale-appropriate.
- Inform regulations, planning policies, and support the broader needs of society.
- Monitor wetland conditions at the regional and operator/site-specific scales. Maximize alignment between the indicators collected at the regional and operator/site-specific scales.
- Drive reduction of cumulative effects from all types of human activity.

Survey

The goal of the survey was to prioritize the potential goals and variables of interest. From the survey, the following results guided the development of a proposal for the wetland monitoring program and goals presented at the workshop:

- The top three monitoring objectives (*1. Collect baseline information to determine the spatial and temporal variability of wetlands; 2. Detect wetland change over time;* and *3. Determine the causes of the observed change*) are inherently linked and perceived as a logically ordered process.
    - Baseline information is used to define and characterize the natural range of variability of wetlands.
    - Change is detected by comparing the conditions of a specific wetland to the baseline conditions.
    - Investigate the cause only when change is detected.
- Although important to measure as a covariate, climate change should not be the main focus of the monitoring program.
- Tracking the long-term trajectory of reclaimed/restored wetlands is important, but should not be a priority for the monitoring program at this time. This objective should be part of the monitoring program in the near future when/if resources are available.

- The three broad categories of wetland conditions of interest were: 1) wetland extent and location, 2) fauna and flora, and 3) hydrology.

Workshop

The goal of the Workshop was to discuss the knowledge gained in this project and to conclude with a collective vision that articulates the goals, objectives, and questions for the Wetland Monitoring Program. The main outcome of the Workshop was the validation of the two goals for the Wetland Monitoring Program:

Goal 1	Goal 2
Monitor the condition of wetlands in the Oil Sands region and measure the cumulative effects of natural and anthropogenic factors on wetlands.	Detect change in wetlands that can be associated with specific anthropogenic activities and can be differentiated from natural environmental effects.

Overall

Through this stakeholder engagement processes, wetland experts and stakeholders collectively agreed that the wetland monitoring program should:

- Be guided by a set of principles:
    - Relevance: The goals, questions, and direction of the monitoring program must be relevant and realistic to supporting the cross-disciplinary needs of the stakeholders.
    - Cost-effectiveness: The monitoring program needs to recognize its limitations and strive to be efficient, effective, and to avoid duplicating existing efforts.
    - Accessibility: Provide data and protocols that are freely and easily accessible.
    - Timeliness: Report data and findings to stakeholders in a timely fashion.
    - Scalability: Allow the program to be tailored and expanded to meet additional monitoring needs or questions.
- Support the needs of key federal and provincial policies and legislations, specifically the Alberta Wetland Policy, Land-use Framework, *EPEA*, Water for Life Strategy, *Species at Risk Act, Canadian Environmental Assessment Act*, and *Migratory Birds Act*.
- Manage the site-specific and cumulative effects of anthropogenic and natural drivers of wetland changes. Central anthropogenic activities to monitor include mining, oil and gas, forestry, agriculture, and urban development. Natural drivers include natural climate variability, fires, drought, pests, and wildlife activity.
- Couple remote-sensing techniques with field-based measurements.
- Continually enhance the wetland inventory based on location, type, and extent of wetlands in the Oil Sands region.
- Create a data management framework and freely accessible data – “open architecture”.

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