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Knowledge transfer process – wetland reclamation research in the Alberta oil sands

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Abstract

To inform a comprehensive revision of the Guideline for Wetland Establishment on Reclaimed Oil Sand Leases document, as produced by the Cumulative Environmental Management Association, a knowledge transfer was initiated in 2008 to capture several years of wetland research results. Subject matter experts, consisting of professors and researchers from academic institutions, were asked to participate in a multi-year process to review, interpret and synthesise results on marsh (open water wetland) reclamation and research in the oil sands region. To best capture the research findings to date, and to ensure that the results of the knowledge transfer could be applied directly to oil sands reclamation, a question-specific approach was adopted where four direct questions were asked of the expert groups. Mine reclamation specific results will be incorporated into the next Wetland Guidelines manual, while a comprehensive treatment of the knowledge transfer results is expected to be published in a peer reviewed journal shortly afterwards. The task group gleaned several integral methodological characteristics of this approach if it is to be utilised: the directors of the process need an intimate understanding of the subject matter and preferably a relationship with the subject matter experts. Financial resources are significant, while time allocation from the task group is even more significant. Buy-in from the subject matter experts through legitimisation and incentives (beyond stipends) are essential, and should be continually reinforced to ensure continued success. Specific knowledge relation tools, such as conceptual diagrams and fuzzy cognitive mapping, are excellent assets and should be explored and utilised where possible in the knowledge transfer process.

1 Introduction

A knowledge transfer (KT) is defined as "a group of activities that increase the understanding of 'a body of research' with the goal of encouraging the application of this knowledge" (Perera et al., 2006). The purpose of this paper is to outline how to effectively design and execute a KT for industrial applications in situations where the primary research of interest has undergone no previous synthesis or compendium of key messages.

In the fall of 2008 a group of Cumulative Environmental Management Association (CEMA) Aquatic Subgroup (ASG) members were granted the opportunity to form a task group to complete a KT regarding wetland research in the oil sands. This group was identified as the Technology Transfer Task Group (TTTG). This group contains members from the oil sands industry and the Government of Alberta, with assistance from CEMA technical advisors as well as a technical consultant hired specifically for the TTTG. Members included Jon Hornung (TTTG co-chair, Suncor Energy Inc.), Carla Wytrykush (TTTG co-chair, Syncrude), and Gerry Haekel (Alberta Sustainable Resource Development). Instrumental in the development and ongoing work are Theo Charette (technical advisor, CEMA) and Marsha Trites (TTTG technical advisor).

This paper will outline the process that was adopted to conduct a KT of relevant research completed on marshes commissioned by or relating to the oil sands mining industry. The paper is separated into seven sections that follow the chronological process as the KT was developed and implemented.

1. Need for summary of relevant data within the oil sands.
2. Understanding the KT process.

3. Development of a unique KT process for this topic and professional network.
4. Communication to participants/decision on direction.
5. Fact sheet generation/key message development.
6. Task group review and application of the focussed approach.
7. Expected outputs.

2 Methods/discussion

2.1 Need to summarise relevant data within the oil sands

Research on wetlands affected by the oil sands industry began as early as 1975 when scientists employed within what is now known as Syncrude and Suncor conducted cursory investigations. Many of these investigations were informal and as a result, no documentation was produced or strict scientific methods adhered to. Nevertheless, these initial investigations illuminated the primary issues in what is now over two decades of oil sands wetlands research.

An important contributing factor to the initiation of this KT was a recent 'rush' of research on wetlands in the oil sands mining industry. Most of the work that contributed to this rush of research was mediated through academic graduate-level thesis research (i.e. masters and doctorate students conducting research and receiving degrees). Oil sands companies understood that commissioning wetland research would enhance their understanding of the reclamation landscape. Primarily, this research was facilitated through CEMA and the Environmental and Reclamation Research Group of the Canadian Oil Sands Network for Research and Development. The research rush further resulted in many of the graduates being hired by the oil sands companies that commissioned the research; and in turn, these graduates understood the state of the science and therefore were in a unique position to undertake a KT. To reiterate: integral to the process, in the opinion of the TTTG, was the direct involvement and past experience with prior research activities of all members and technical staff.

The need to summarise the data was further spurred by the upcoming revision of CEMA's Guideline for Wetland Establishment on Reclaimed Oil Sands Leases also known as the Wetlands Guide (Alberta Environment, 2008), last revised in 2007. It was determined by the ASG that a KT would be integral to the comprehensive revision of the Wetlands Guide in 2011–2012. This requirement allowed for a significant level of funding (C$ 200K+) and commitment (300+ collective days) required for the KT process to be executed.

2.2 Literature review on the KT process

A literature search for standard methods to apply to this topic and the academic/industrial environment within which this KT was implemented, provided only disparate results. While several papers provided general statements on the mechanism, or recommendations to best facilitate the transfer of knowledge, none of the literature acquired was directly applicable to this situation. Most useful were the general guidelines for a successful KT. These are included in Table 1.

Table 1 Components of KT/TT strategies summarised from literature

Components of Effective Strategies	Source	TTTG Using this Component?
Face-to-face, two way exchange between researchers and research users	Mitton et al. (2007), Lavis et al. (2003)	Partial
Facilitated meetings between decision makers and researchers	Mitton et al. (2007)	Partial
Interactive education session for decision makers	Mitton et al. (2007)	Outside our scope?
Interactive multidisciplinary workshops	Mitton et al. (2007)	Yes
Web-based information, electronic communications to augment interaction	Mitton et al. (2007), Lavis et al. (2003)	Yes
Steering committees or team directing efforts	Mitton et al. (2007), PCECY at CHEO (2006)	Yes
Include rewards and credit/recognition for participants	PCECY at CHEO (2006)	Yes
Built in flexibility	PCECY at CHEO (2006)	Yes
Recommendations clearly spelled out with supporting credible research evidence directly aligned with each	Dobbins et al. (2004)	Yes/our ultimate goal
Non-effective		
Literature review	Lavis et al. (2003)	No
Presentations or non-interactive education sessions	Bero et al. (1998)	No
Push methods: researcher initiated and generated KT	Mitton et al. (2007)	No

Other general points gleaned from the literature cited above include:

- Design the group to evolve naturally–allow participants to define structure and learn as you go.
- Welcome and allow different levels of participation.
- Focus on the value of the group, and convey this value to the group.
- Combine familiarity and excitement.
- Find and nurture a regular rhythm for the group.
- Recognition of different types of knowledge (a spectrum from speculation to peer-reviewed articles).

2.3 Development of a unique KT process for this topic and subject matter expert network

When the TTTG realised that a simple standard protocol manual for KT was not available, the group decided to forge ahead and learn as we go. The first step was to ask for guidance from those that have implemented KT in the past, who had also adopted the 'learn as we go' mantra. A previous KT was completed on research related to upland soil placement techniques in the oil sands three years previous to this; the TTTG talked with those involved. We heard from both an active participant and the organiser of that KT; significant advice included:

- Do not gather people together for an unstructured discussion on the general topic. This approach will result in many mixed messages and no clear key result(s).
- Err on the side of focussing the participants. Some may feel limited, but the information you lose will be insignificant compared to the clear directed messaging that results.
- Be results oriented, and understand the final deliverable before you engage experts.
- It takes a lot of work–a high level of commitment is required from the organising committee (TTTG).

The second phase of KT methods development was to engage a select few subject matter experts (SME) to test our approach (also referred to as primary scientific leads (PSLs)). These initial SMEs were trusted, patient individuals who were willing to help nurture the process. Lesson learned from these SMEs included:

- Must work hard to achieve buy-in from the SMEs; without a clear demonstration to these knowledge holders that the process is worthwhile, lack of collaboration would lead to failure.
- Must ensure the SMEs feel safe to share ideas, or feel justified in withholding a few appropriately confidential ideas.
- Must provide a 'carrot' for the SMEs – outside of payment – for true participation.

2.4 Communication to participants/decision on direction

Several meetings were required to prepare an initial and integral communication brief to the SMEs. Also discussed during these meetings was the decision on the path forward to achieve our goals. The extended planning in advance of engaging the SMEs helped to prepare the TTTG team for the process and facilitated buy-in from the SMEs. The TTTG made the best use of the advice we received by incorporating the following attributes into the KT:

- Focus: the TTTG chose four discrete questions that could best capture the most pressing questions and yet condense the knowledge to date.
- Pragmatism: It was determined that marshes were the only wetland type that had a sufficient amount of research completed to draw out key messages.
- Goals: TTTG clearly articulated the goals of the programme to the parent committee (ASG) and the SMEs.
- Legitimisation: ensured SMEs understood the final product, and how useful and important it would be to wetland research in the oil sands.
- Incentive: the 'carrot' was not only monetary stipend for their involvement, but also the clear articulation that our goals included publication of multiple papers with all SMEs as co-authors.
- Comfort: TTTG ensured the sharing of ideas was kept confidential until the written report was approved for release outside of the TTTG by the contributing SMEs.
- Commitment: with a detailed path forward, scheduled meetings and workshop dates almost two years in advance, SMEs fully understood the commitment they were making–this also legitimised the process. Further, the TTTG-member's commitment was outlined (Table 2); this gave the SMEs confidence in the quality of the final product.
- Agility: while the meeting dates and meeting duration were articulated early, the processes to achieve goals were determined only as the TTTG learned what worked best.

2.5 Fact sheet generation/key message development

To begin the project, and to initiate engagement with the SMEs, the TTTG asked SMEs to write fact sheets derived from the papers and reports they had published, in a condensed format. The fact sheet consisted of the following headings: author, title, questions and/or objectives, key messages for industry, methods, results and further research needs. It was requested that the fact sheets be no longer than three pages, and each

would be included in an appendix of the final report, ultimately for public dissemination. Many SMEs eagerly participated (~85% of requests); further, some included research and work yet to be published or never intended to be published. The research represented by the SMEs that declined the opportunity to provide a fact sheet, or those which were not able to be contacted, had to be synthesised by the TTTG. Participating SMEs were paid a stipend per fact sheet for their participation. Many of the fact sheets required additional dialogue with SMEs to further refine. The most common causes for refinement were SMEs submitting fact sheets that were too long and TTTG's requirement of the SMEs to create key messages that were implementable for industry.

2.6 Task group review of the focussed approach

As mentioned previously, the four questions that were devised by the TTTG to focus the KT were:

1. What is the threshold concentration of naphthenic acids to allow for natural marsh function?
2. How to manage salinity within the context of wetland biological function?
3. Do oil sands operators need to add capping materials to establish viable marshes?
4. What are the ten parameters that should be measured to demonstrate "equivalent wetland capability" as a process to compare natural and reclaimed marshes?

These were addressed in chronological order, and ordered from those suspected to be easiest to most difficult (complex) to answer. In addition, questions were ordered in sequence of those that could inform the subsequent question; that is, considering salinity in the absence of naphthenic acid concentration (a compounding toxic element) is folly. Prior to assembling the SMEs, the TTTG spent considerable time anticipating the responses and concerns of the specific SME groups assembled for each question. The questions allowed focus for the KT, but as TTTG worked through the process the questions became more refined in discussions with the SMEs. This is another example of needing flexibility in the process. It is important to stress that the effort devoted to attaining 'buy-in' and legitimisation of the project paid great dividends when we assembled the larger group of experts. The TTTG stresses the importance of this step to ensure a smooth process and for long term success.

2.6.1 Naphthenic acids workshop

The manner in which the TTTG addressed this question was the most unstructured. A concern of the group was that although a focussed question was asked, and we were limiting the discussion to the subset of wetlands classified as marshes, that the discussion might yield only ambiguous group ramblings. A facilitator's role is very important at this step. The facilitator must ensure that the conversation keeps moving through the significant key messages outlined in the fact sheets, yet not make the SMEs uncomfortable and rushed. Further, the facilitator must pick out key messaging in the discussion, and look for consensus among the SMEs. The facilitator (or chair) of the workshop must be supported by the TTTG, to take notes, and to help think critically about the key messages, if they are appropriate to translate into practice, and/or require further refinement.

Another measure employed by the TTTG to ensure a successful meeting was to develop several sub-questions under the main question. For example, a sub-question of #1 was: 'What are naphthenic acids?' Although many sub-questions were prepared, in this case they were not required as the workshop SMEs participation was highly productive and informative. This workshop was attended by ten SMEs, in two separate groups.

Finally, the TTTG understood that there were two very distinct sub-disciplines represented at the meeting; toxicologist-chemistry (4) and ecology (6). It was decided that these would be split to discuss these questions separately, and to only share final key messages together to look for consensus.

2.6.2 Salinity

Integral to our approach was the utilisation of the results of the previous workshop(s) in the subsequent workshops. Naphthenic acids and salts occur together in oil sands process-affected waters, therefore it was important to consider them together. This workshop was started with a thorough review of the key messages

developed by the previous group. Again, a facilitator had to ensure a productive environment, and the TTTG benefited greatly from the legitimisation of the process. More SMEs attended this workshop (10) which resulted in a greater number of potential key messages, but also difficulty in reaching consensus among the SMEs on those messages. A useful solution to the myriad of opinions on this subject was the development of a conceptual diagram for the separation of marshes along a gradient of salt concentration, and their expected outcomes. The use of the conceptual diagram highlights the flexibility the TTTG exercised when engaging SMEs; its worth was translated into the process to engage SMEs in the following question.

2.6.3 Soils placement / geological engineering

The third question again employed the techniques honed during the first two questions (reviewing past workshop results, active facilitation and support, build on SME buy-in), but added the development of conceptual diagrams as a goal. With a small group of SMEs attending this workshop (4), a series of conceptual diagrams were developed and agreed upon. Further, conceptual diagrams may have been highly appropriate for this workshop as the subject matter was geological/hydrogeological in nature.

2.6.4 Wetland indicators of function

This question was considered to be the capstone of the oil sands marsh research KT process. The TTTG understood that many researchers had been working towards the development of these indicators either directly or indirectly, and this may only refuel the debates between the sub-disciplines represented among the SMEs. Further, this question would include the largest group of SMEs (13). For these reasons, and to utilise a tool that was well suited to our question, the TTTG decided to use cognitive fuzzy mapping to capture the intricate knowledge available from the SMEs.

2.6.4.1 Fuzzy cognitive mapping

A fuzzy cognitive map (FCM) is a cognitive map within which the relations between the elements (e.g. concepts, events, project resources) of a 'mental landscape' can be used to compute the 'strength of impact' of these elements. During the TTTG workshop to identify indicators in wetlands, SMEs were grouped into groups of three with sub-disciplines balanced (attempt to group an ecotoxicologist/chemist, hydrogeologist, and ecologist together). Each group received a list of over 100 concepts (e.g. biomass of vegetation, concentration of salt), and asked to link the important concepts together on a map. With each linkage the group had to identify the strength and level of confidence they have in the association.

These maps were then collected, tabulated and results combined and averaged to produce the overall FCM for the larger group. Particular concepts were able to be identified as those that were drivers (most associations coming out of to influence other concepts), receivers (most associations going into), and central or key concepts (most associations going in or out of). This approach has been used before to understand ecosystem processes (Hobbs et al., 2002). SMEs were initially sceptical of the approach, and the legitimisation of this technique was aided through one of the SMEs spearheading the approach in a prior exercise.

Understanding the system, and gaining consensus on which variables (or concepts) are the drivers and receivers is only the beginning of what can be accomplished with a FCM data. Exciting results are furnished by treating the overall map as a model for the system (wetland) that is being mapped and complete what could be described as a sensitivity analysis on key variables. This process is completed with a process known as leveraging, also gaining popularity in the literature (Giles et al., 2008; Hobbs et al., 2002). It became clear through the workshop that the FCM approach would provide many benefits including; a holistic method for knowledge synthesis, design and management guidance for wetland reclamation, and potential variables to be used as indicators to track reclamation success.

It is very important when conducting a FCM workshop, with a large group of experts working independently within groups, that some important details are very clear to the SMEs. Participants must fully understand and agree upon the concepts they are linking together. This is the cornerstone and achilles heel of the FCM process. Further, and equally important, is that participants must have consensus on what they are mapping. In this case, much discussion was needed to detail that the FCM process applied to marshes, in the oil sands region, and included both disturbed and undisturbed systems.

2.7 Expected outputs

Given the significant cost and employee-hours needed to conduct this KT, it is imperative that the outputs have impact and are utilised. Table 2 is an estimate of the time, in full working days, that the TTTG and the SMEs have contributed to this endeavour.

Table 2 An estimate of the full working days devoted to the oil sand marsh research KT

Task	TTTG Days	SME Days
KT literature review	6	
Fact sheets development and refinement	58	30
Process development/budget	40	
Workshop planning	120	
Workshop attendance	60	120
Information dissemination/updates/writing	15	
Final report	70	40
Subtotal	369	190
Total estimated person days for KT	559	

The output expected to be directly implemented is the contribution of the key messages, conceptual diagrams, and indicators to the Wetland Guide. This document will serve as a guide for all operators when reclaiming landscapes and managing wetlands in the oil sands. The SMEs were incentivised by the promise of publication of these results. While these papers will undoubtedly serve to educate the scientific community on the issues and potential solutions in the oil sands, an indirect result will be the focussing of new wetland science, and identification of knowledge gaps for research in the oil sands. Finally, the networking and relationship building amongst academic and industry scientists represents an intangible, yet significant result. These relationships will very likely be relied upon when commissioning the next phase of research in the oil sands.

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