Future of Shrubs in Oil Sands Reclamation Workshop

Oil Sands Research and Information Network

University of Alberta

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Information Network

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The Oil Sands Research and Information Network (OSRIN) is a university-based, independent organization that compiles, interprets and analyses available knowledge about managing the environmental impacts to landscapes and water impacted by oil sands mining and gets that knowledge into the hands of those who can use it to drive breakthrough improvements in regulations and practices. OSRIN is a project of the University of Alberta's School of Energy and the Environment (SEE). OSRIN was launched with a start-up grant of $4.5 million from Alberta Environment and a $250,000 grant from the Canada School of Energy and Environment Ltd.

OSRIN provides:

- **Governments** with the independent, objective, and credible information and analysis required to put appropriate regulatory and policy frameworks in place
- **Media, opinion leaders and the general public** with the facts about oil sands development, its environmental and social impacts, and landscape/water reclamation activities – so that public dialogue and policy is informed by solid evidence
- **Industry** with ready access to an integrated view of research that will help them make and execute environmental management plans – a view that crosses disciplines and organizational boundaries

OSRIN recognizes that much research has been done in these areas by a variety of players over 40 years of oil sands development. OSRIN synthesizes this collective knowledge and presents it in a form that allows others to use it to solve pressing problems.

Citation

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Copies of this report may be obtained from OSRIN at osrin@ualberta.ca or through the OSRIN website at http://www.osrin.ualberta.ca/en/OSRINPublications.aspx or directly from the University of Alberta's Education & Research Archive at http://hdl.handle.net/10402/era.17507.

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REPORT SUMMARY

A group of 48 people from government, academia, consultants and the oil sands and plant production industries gathered on November 25, 2013 to discuss the current state of knowledge about shrubs and their current and future use in oil sands reclamation. The Workshop was organized around four key topics:

- Session 1: Regulatory Requirements and Policies
- Session 2: Current State of Knowledge
- Session 3: Knowledge Gaps and Policy Needs
- Session 4: Next Steps

In Session 1, participants noted a number of regulatory requirements and policies that support shrub use. However, a far larger list of impediments was identified. These can be roughly divided into two main themes: (1) impediments to efficient and effective use of shrubs; and (2) impediments to effective ecological use of shrubs.

In Session 2, participants said we know *which* species to use but maybe not *why* – current planting density rules require x stems/ha and species doesn't matter so there is no incentive for diversity or selection of species attributes that could be exploited to enhance reclamation success. Participants felt collection, storage, growing and seeding issues are understood for 50% to 75% of species but some are very difficult to germinate and grow. They noted that shrubs are not produced commercially in the volumes needed, and this will be even more of a problem when reclamation ramps up in terms of area per year. Participants felt that we have a relatively good understanding of shrub reclamation for *regular reclamation sites* (no inhibiting factors) for both early and late successional species but we are not as advanced for early successional stages in challenging sites and have little knowledge and experience with late successional species in challenging materials. Finally there was the sense that there are lots of people and sources of information available. Much of the information is in grey literature; the comment was made that we also need to recognize *grey knowledge* – the knowledge (generally operational experience of growers and company reclamation staff) that isn't even written down. A better mechanism is needed to access and share the information.

In Session 3, participants provided a long list of characteristics that could be used to determine successful shrub reclamation, but noted that success was seen to be determined by the goal, policy, scale, or timeframe. A long list of research needs was identified, mostly grouped into categories such as: (1) synthesis of existing knowledge, (2) developing *how to* guidance, (3) developing and improving seed management practices, and (4) monitoring outplanting results. In terms of scale of research needed, lab and greenhouse tests could be used to pinpoint the causes of problems observed in the field, while landscape level studies are required to understand the interaction with environmental variables (soils, climate, other species) and provide proof of concept / ability / success. Participants provided some context for revising policies and then provided specific changes that are required to improve efficiency and effectiveness of shrub reclamation.

In Session 4, participants suggested that a *shrub research roadmap* be developed (an alternative for a broader revegetation roadmap was also suggested). The roadmap would begin with a compilation of existing knowledge which would lead to development of an Action Plan. A team would have to be established to steer development of the roadmap and to secure funding; similarly a home for the project would be required – COSIA, OSRIN or CEMA were suggested as potential homes.

Some key projects suggested to be included in the Action Plan are:

- A gap analysis (flowing from the compilation of existing knowledge)
- Recommendation to government of policy changes necessary to support effective and efficient use of shrubs for reclamation
- Confirmation of reclamation goals and criteria relative to shrubs to allow for focused research and development work
- Retrospective analysis of existing reclaimed sites
- Best Management Practices for shrub use (collection, propagule management, deployment)
- An evaluation of the feasibility, location(s) and costs of seed orchards / stoolbeds
- A shrub monitoring program, including protocols that all operators will follow to ensure a common set of data
- Establishing a system to share existing and developing knowledge and coordinate future work
- Inventory of experts who can / will share knowledge
- Identification of training needs, and development and deployment of training programs
- Review the role of the Oil Sands Vegetation Cooperative, particularly if the rules governing plant and seed collection and movement are changed

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OSRIN is grateful for the efforts of the members of the Workshop Steering Committee:

- Amanda Schoonmaker – NAIT
- Ann Smreciu – Wild Rose Consulting
- Brett Purdy – Alberta Innovates – Energy and Environment Solutions
- Gillian Donald – Donald Functional & Applied Ecology Inc.
- Jay Woosaree – Alberta Innovates – Technology Futures
- Lori Neufeld – Imperial Oil
- Robert Vassov – Shell
- Simon Landhausser – University of Alberta
- Tim Vinge – Alberta Environment and Sustainable Resource Development

1 INTRODUCTION

A group of 48 people from government, academia, consultants and the oil sands and plant production industries gathered on November 25, 2013 to discuss the current state of knowledge about shrubs and their current and future use in oil sands reclamation.

Shrubs are an important component of the understory of boreal forests and are used to classify Ecosite Phase (e.g., b1 blueberry, jack pine-aspen; Alberta Environment 2010). The *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region 2nd Edition* (referred to regionally as the Revegetation Manual; Alberta Environment 2010) recommends shrub planting densities of 500 to 700 stems/ha and requires that the diversity of understory species (including shrubs) achieve levels more typical of juvenile stands. Characteristic shrub species numbers vary by ecosite from a low of 5 in ecosites g and h to a high of 23 for ecosite e (Alberta Environment 2010).

The Workshop Agenda is provided in Appendix 1 and the list of attendees in Appendix 2. This report is organized around the four key topics of the Workshop:

- Session 1: Regulatory Requirements and Policies
- Session 2: Current State of Knowledge
- Session 3: Knowledge Gaps and Policy Needs
- Session 4: Next Steps

Each Session began with opening remarks that set the stage for group discussions of a set of questions posed by the Organizing Committee (see Appendix 3). Groups were also encouraged to discuss related issues as they arose. Each Group was asked to provide summary notes of their discussions (Appendices 4 to 7).

In this document:

Yellow shaded boxes are additional explanatory materials sourced from documents referenced by participants in their notes
Green shaded boxes are additional comments provided by participants after the Workshop
Blue shaded boxes are comments provided by people who were invited to, but could not participate in, the Workshop

In his Introductory remarks Chris Powter noted that this is the second major workshop looking at the use of shrubs in oil sands reclamation – the first having been held in 1978. A summary of the 1978 Workshop is provided in Appendix 8. Although some progress can be seen, sadly many of the recommendations from the 1978 Workshop are mirrored in this 2013 version.

2 SESSION 1: REGULATORY REQUIREMENTS AND POLICIES

Participants noted a number of regulatory requirements and policies that support shrub use, including:

- EPEA approval requirements and identification of reclamation goals (productive, locally common boreal forest)
- Revegetation Manual
- Adaptable and flexible reclamation plans (Closure Plan and Reclamation Plan)
- Encouragement to undertake progressive reclamation

However, a far larger list of impediments was identified. These can be roughly divided into two main themes: (1) impediments to efficient and effective use of shrubs; and (2) impediments to effective ecological use of shrubs.

In terms of impediments to efficient and effective use of shrubs, the following key points were made:

- Seed zones that are split by geography (e.g., Athabasca River) create significant hurdles for oil sands operators that have reclamation responsibilities on both sides of the river; suggest redrawing seed zones for the region to accommodate these special circumstances

> When considering changes to seed zone regulations, we need to consider:
>
> - Survival
> - Reproduction
> - Biomass (e.g., productivity)
> - Pests/disease resistance

- Restrictive regulations involving the size of the target collection area for point collections limit potential seed lot size and therefore lead to excessive numbers of seedlots (combining seedlots within the same seed zone (seed zone collection) is possible but then they cannot be deployed outside of the seed zone)
- Alberta Forest Genetic Resource Management and Conservation Standards (FGRMS) were developed for trees not shrubs. Therefore these rules are untested in terms of the appropriateness for shrub seed movement. There is a need for flexibility in the standards to accommodate shrubs. However, standards are unlikely to change significantly without an appropriate level of research (data) on the genetic variation in shrubs to support changes.

In terms of impediments to effective ecological use of shrubs, the following key points were made:

- System encourages multiple collections over time from same large source area rather than encouraging more genetic diversity by allowing pooling of smaller collections from more sites
- Some shrub species are best deployed in later successional stages but the current rules incent immediate deployment of all species (e.g., lowbush cranberry needs shade and won't survive until there is an overstory – we know what to plant but don't plant it at the right time)
- Current shrub density rules (500 to 700 stems/ha) in the Revegetation Manual don't account for natural emergence / invasion therefore companies are forced to plant the full 500 to 700 stems to meet the density requirement (prickly rose was given as an example of a volunteer species)

2.1 Non-Regulatory Impacts on Shrub Use

While the session focused on regulatory requirements and policies that support or impede shrub use there are a number of other factors that impact shrub use. Of particular note is the significant, and increasing, intellectual and delivery capacity in the province reflected in the diversity of workshop participants.

Other factors include:

- The Oil Sands Vegetation Cooperative (OSVC) is collecting and storing seeds of a variety of tree and shrub species[1]
- While supply of seed may not be an issue now, in the future there will be fewer undisturbed patches to harvest from
- Seedling production is geared for single species in large numbers (e.g., forestry) rather than small volumes of numerous species (e.g., oil sands)
- The effect of climate change on future application of seed zones has not been addressed in the application of the regulations (particularly an issue for oil sands mines that have very long reclamation timelines)

> This issue is broader than just oil sands – all disposition holders that create surface disturbances should be treated the same and should be part of the discussion and the solution.

[1] See http://www.cosia.ca/initiatives/land/oil-sands-vegetation-cooperative

3 SESSION 2: CURRENT STATE OF KNOWLEDGE

The following key points were raised during the discussions of the questions.

3.1 Do We Know Which Shrubs to Use And Why?

Yes, but those that are easy to grow may not be the ones labeled *characteristic species* in the Revegetation Manual. We know *which* ones to use but maybe not *why* – current planting density rules require x stems/ha and species doesn't matter so there is no incentive for diversity or selection of species attributes that could be exploited to enhance reclamation success.

3.2 Do We Know How They Can Be Collected, Stored, Grown And Seeded/Planted?

Collection, storage, growing and seeding issues are understood for 50% to 75% of species but some are very difficult to germinate and grow. It is important to remember that shrub propagules are readily available in salvaged soil, therefore salvage and direct placement, is a very good method of collection and planting.

Collection is well known (based on phenology), however seed crops are highly variable year to year and different species seed at different times making collection a time-consuming (and therefore expensive) task. This is even more problematic when access to sites is difficult.

Short term storage requirements are known for *orthodox* species but less is known about long term storage. Seed viability is highly variable, both spatially and temporally. Overcoming dormancy can take long time therefore it is difficult to plan for field deployment.

It was noted that most shrub work is done with seeds as cuttings are too expensive.

There was some concern that knowledge is being horded (e.g., proprietary nursery procedures) which impedes efficient accumulation of knowledge.

3.3 Can We Get The Shrubs We Need When We Need Them?

Shrubs are not produced commercially in the volumes needed, and this will be even more of a problem when reclamation ramps up in terms of area per year. Successful production requires good planning. Growers noted that they need at least two years notice from collection to delivery (currently they are often given one year or less); for even greater protection they recommend allowing two years collection and two years growing. Participants also noted that seed yield varies considerably year to year and therefore a bad year can significantly reduce subsequent availability of stock.

Consistent demand year to year would help to support private growers. Clarity on the species that are in demand, and those that will be more specialized or sporadic, would also help in business planning.

The Oil Sands Vegetation Cooperative has several years of seed from mineable oil sands areas stored now. This helps ensure quicker and more reliable availability of planting stock.

The availability of land and cost of production facilities (e.g., nurseries, orchards, stool beds) is a hurdle but these facilities could mitigate seed supply concerns. These have been developed for trees because of the ability to cooperate with forestry.

3.4 Do We Know How Shrubs Perform in Reclamation Setting(s)?

There were mixed views on this:

> No; minimal information available in reclamation settings; may have general information (e.g., shrubs as a group) but not species specific.

> We are creating novel ecosystems – this in itself creates significant uncertainty in outcomes.

> Yes; for some species (e.g., *Salix* and *Alnus* do well because they are pioneer species with wide adaptability and are easy to propagate in large quantities)

We have a relatively good understanding of shrub reclamation for *regular reclamation sites* (no inhibiting factors) for both early and late successional species but we are not as advanced for early successional stages in *challenging sites* and have little knowledge and experience with late successional species in challenging materials.

> Based on the comments and discussions the present focus seems to be on shrub reclamation and everything associated with that endeavor for such features as overburden dumps and other (generally) "good" reclamation surfaces. The establishment of shrubs on tailings deposits does not appear to be on the radar at this time; however, currently being involved in two tailings sand reclamation projects, I know that these deposits await reclamation with an increasing frequency over the next 5 to10 years. As is, the apparent data "gap" for shrubs on other reclamation features is more of a data "abyss" for tailings deposits, with their extremely complex gradients of surface water, groundwater, salinity (and other "contaminants, such as hydrocarbons and metals), exposures, elevational deltas, etc.

We have been planting shrubs for a long time but the ability to do a retrospective review of success may be hampered by confounding factors (e.g., changing reclamation soil prescriptions, changing species), record keeping and adequate data. For example, we monitor tree and shrub planting densities (because density is specified in the Revegetation Manual) but aren't tracking other key success parameters (such as those identified in s. 4.1 below).

3.5 Do We Know Where (From Whom) to Obtain Information?

Yes, there are lots of people and sources of information available. Much of the information is in grey literature; the comment was made that we also need to recognize *grey knowledge* – the knowledge (generally operational experience of growers and company reclamation staff) that isn't even written down. A better mechanism is needed to access and share the information.

Information needs to be readily available, easily accessible and understandable by the intended audience.

One grower noted that he had a lot of information and experience to share but no one is asking for advice.

We should be open to information from other disciplines, such as forestry, agriculture, horticulture, shelterbelt programs, as well as mining experiences in other regions.

4 SESSION 3: KNOWLEDGE GAPS AND POLICY NEEDS

The following key points were raised during the discussions of the questions.

A number of participants noted that future conditions and constraints will be different than they are today – therefore research, planning and policy must be forward looking rather than just addressing today's challenges. Examples included:

- Climate change could impact availability of materials for collection and suitability of materials for deployment
- As development proceeds there will be fewer local undisturbed areas available for propagule collection
- As pace of reclamation accelerates there will be increasing pressure on collectors and growers to provide greater volumes of materials
- There is a trend to requiring more species to meet biodiversity, traditional use and other goals
- There is a trend to more wetland and riparian reclamation that will require new plant species

4.1 What Constitutes "Successful Shrub Reclamation"?

Participants provided a long list of characteristics that could be used to determine success:

- Presence
- Survival

- Growth
- Biomass production (ability to occupy site and compete) / density
- Diversity of species / community composition
- Natural morphology
- Root system
- Reproduction (fitness and success) / reproductive capacity
- Seed / vegetative dispersal
- Healthy / robust / resilient (adapts to biotic and abiotic stressors; resists insects and disease)
- Natural mortality rates (or better) emulated on reclaimed land
- Future persistence (stress, disease)
- Forms part of ecosite target
- Fulfilling ecological role
- Providing wildlife habitat and food sources
- Successional role / stage / trajectory
- Suitable to the site
- Site stability / erosion control
- Absence of invasive species
- Mature reclamation unrecognizable as previously disturbed
- Meets social need / Aboriginal use

Success was seen to be determined by the goal, policy, scale, or timeframe.

- Answer depends on goal / target (what was pre-disturbance state; what is land use)
- Answer is policy driven: meets Revegetation Manual characteristic species table or meets 2010 upstream oil and gas forest criteria
- Answer depends on scale – individual, plot, landscape
- Answer depends on timing (when to measure – after planting? 25 years later?)

4.2 What Research Is Required Into Shrub Species Selection?

A variety of topics were highlighted during the group discussions. Some of the key ones are listed here.

- Summarize existing research on shrub autecology and synecology

- Document current practices (a manual?) and assess why past plantings have succeeded or failed (did the approach lead to achievement of goals)
- Develop an understanding of a variety of ecological and operational practices that affect successful use of shrubs in reclamation
- Develop an understanding of shrub genetic variability with distance to determine if the tree seedlot standards apply to shrubs
- Explain how to select appropriate species from the Revegetation Manual characteristic species table, based on the underlying functional connection of the shrub species in a forest ecosystem
- Determine when to deploy materials for best establishment success

4.3 What Research Is Required To Collect, Store, Grow And Seed/Plant Shrubs?

Before we jump to specific research projects we need to clearly identify what the problem is we are trying to solve – is it seed availability, seed quality, seed storage and viability, seedling production or …?

The answer was felt to be species-specific and the groups recommended various ways to set priorities on which species to focus on:

- Focus on *problem species* (those that are hard to work with in any of the procedural categories)
- Focus on *keystone* or *foundational* species (based on functional role in ecosystem)
- Focus on *colonizing* species

Some specific project needs included:

- Develop means to predict when seed crop will be ready to harvest
- Develop criteria for evaluating seed quality (cut tests, germination tests)
- Germination and growth could use considerable research
- Understand dormancy and how to break it
- Develop an Alberta oil sands-based Seed Collection, Preparation and Storage Manual

> The University of Saskatchewan’s ongoing project about seed storage and germination requirements will address many of the questions, but genetic variability studies seem to be an area that can lead to a lot of practical implications.

A number of needs were identified relative to planting:

- Test stock types and sizes, root/shoot ratios
- Identify appropriate stock handling methods
- Assess the performance risks of using vegetative cuttings vs. seedlings
- Determine when to plant (spring / fall)
- Assess hot planting vs. dormant
- Determine appropriate planting densities
- Assess mixed species plantings (to identify potential facilitative synergies)
- Determine microsite design(s) to facilitate shrub establishment
- Assess early mortality rates
- Determine when to assess success

Participants would like to see the experiences of people, trials / research, and operations documented and made widely available. It was also noted that training of people involved in all facets of shrub handling is required[2] and that more trained people would significantly improve chances of success.

> The data collected by companies and their consultants should be pooled and synthesized so "repeatable" conclusions can be drawn and applied to operations.

4.4 What Scale Of Research Is Required – Lab, Plot, Large-Scale Demonstration?

All scales are needed (lab, greenhouse, plot, large scale demonstration, operational trials). Lab and greenhouse tests could be used to pinpoint the causes of problems observed in the field. Landscape level studies are required to understand the interaction with environmental variables (soils, climate, other species) and provide proof of concept / ability / success.

4.5 What Policies Are Required Or Need To Be Updated?

The groups noted a number of factors that should be considered when updating existing policies or creating new ones:

- Ensure the objective of policy is to gain approval (certification)

[2] Although not specifically addressed by Workshop participants this could provide an opportunity for engagement of local Aboriginal communities.

- Establish policies that best minimize risk in the longer term (e.g., genetic maladaptation = species not suited to site, species interactions, ecosystem function)
- Establish policies that encourage cooperative work towards an accepted, common goal
- Adjust policies to be less prescriptive and instead focus on outcomes (ecological restoration / function, ecological processes established)

The groups also identified specific policy revisions:

- Clarify genetic resource management and biodiversity requirements in legislation and/or EPEA approvals
- Add shrub research requirement into EPEA approvals (if not already covered by clauses related to participating in research groups like CEMA)
- Update the Revegetation Manual to identify natural / reclaimed analogues and early successional species
- Update FGRMS collection and registration requirements
- Adjust FGRMS rules to fit shrubs
- Use Regional Zones for seed (e.g., 50 km radius)
- Adjust policies to reflect potential climate change impacts on species choice and seed / plant movement (assisted migration)

When given a hypothetical chance to have funding the fill the *top priority knowledge gap* participants were unable to agree on a single topic; instead they identified a variety of key gaps they would focus on:

- Genetic variability
- Planting stock quality and deployment methodology
- Natural ingress into large disturbed areas (species, distance, method, success)
- Identification of causes of failure
- Best form of propagule to use

5 SESSION 4: NEXT STEPS

Participants identified a number of steps required to increase the efficient and effective use of shrubs for oil sands reclamation. A key recommendation was the need to develop a *shrubs research roadmap* (one group suggested this could be expanded to be a *vegetation roadmap*). Figure 1 and Table 1 outline the preliminary scope and responsibilities for roadmap development and deployment. A lead group such as COSIA, OSRIN, or CEMA will be required to make sure this long term initiative is successful. Following compilation of current knowledge there will be a number of research needs identified – research will have to be prioritized to ensure the most important items are addressed within available budget levels.

Some key projects suggested to be included in the action plan are:

- A gap analysis (flowing from the compilation of existing knowledge)
- Recommendation to government of policy changes necessary to support effective and efficient use of shrubs for reclamation
- Confirmation of reclamation goals and criteria relative to shrubs to allow for focused research and development work
- Retrospective analysis of existing reclaimed sites
- Best Management Practices for shrub use (collection, propagule management, deployment)
- An evaluation of the feasibility, location(s) and costs of seed orchards / stoolbeds
- A shrub monitoring program, including protocols that all operators will follow to ensure a common set of data
- Establishing a system to share existing and developing knowledge and coordinate future work
- Inventory of experts who can / will share knowledge
- Identification of training needs, and development and deployment of training programs
- Review the role of the Oil Sands Vegetation Cooperative, particularly if the rules governing plant and seed collection and movement are changed

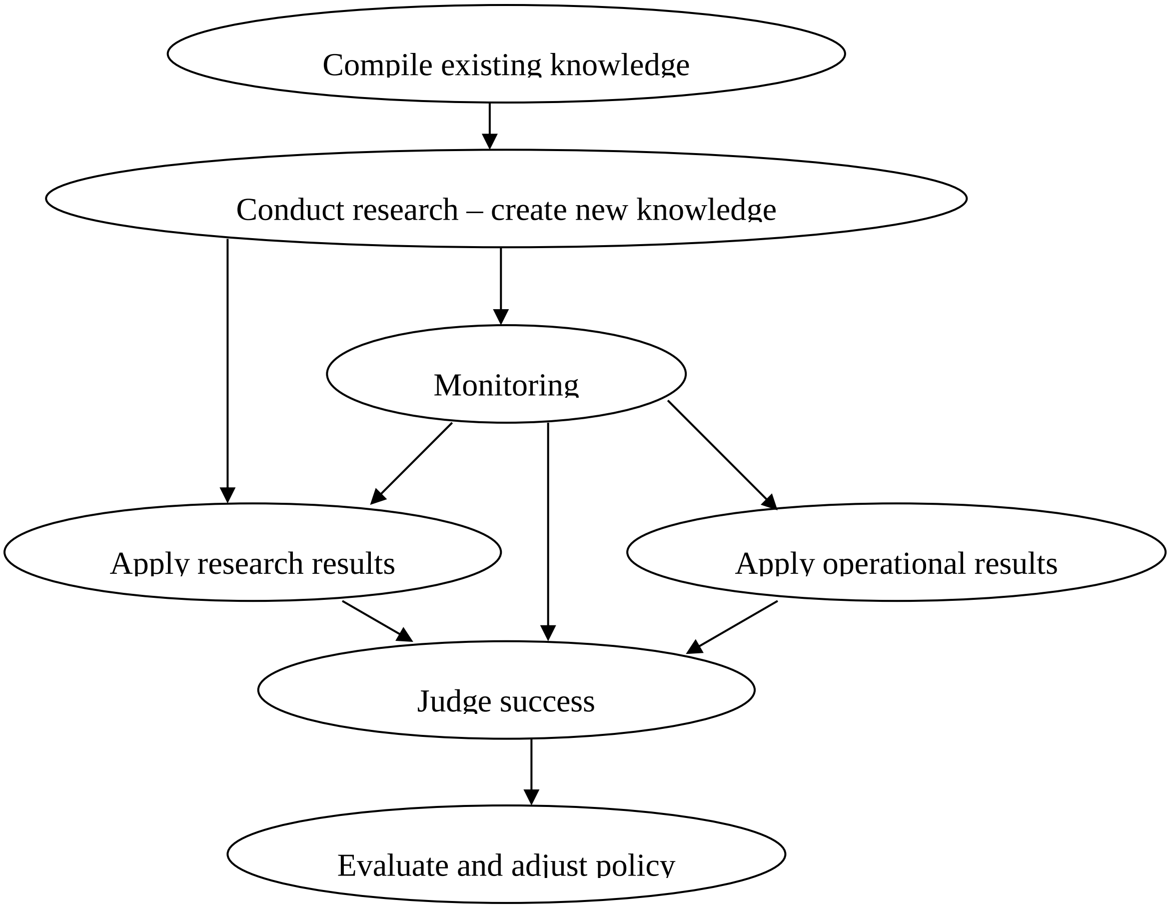

Figure 1. Key steps in shrub research implementation plan

Table 1. Key steps and responsibilities in shrubs research; *public* includes Aboriginal communities
Refer to Figure 1 for sequence of steps
Green cells indicate lead role; yellow cells indicate supporting role

Action	Industry	Researchers	Growers	Consultants	Regulators	Public
Compile existing knowledge						
Conduct research – create new knowledge						
Monitoring						

Action	Industry	Researchers	Growers	Consultants	Regulators	Public
Apply research results to operations						
Apply monitoring results to operations						
Judge success						
Evaluate and adjust policies						

Participants noted this work needs to start immediately. Although there are currently relatively small blocks of land available for reclamation, the demand for shrubs will increase dramatically as larger blocks of land become available (likely by 2035).

The cost of developing the action plan will be relatively small. However, participants noted that the research arising from the action plan will be long term and very expensive.

6 INFORMATION SOURCES

6.1 Legislation and Policy

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7 GLOSSARY

Most of these terms have been taken from the Alberta Forest Genetic Resource Management and Conservation Standards.

7.1 Terms

Characteristic Species

Those species that are either:

- Present in a minimum of 70% of the sample plots for a given vegetation class; or
- Have a prominence value of 20 or greater, where
  prominence value = $\sqrt{\%\text{frequency x } \%\text{cover}}$

Deployment

Establishment of a new stand through artificial regeneration; through physical movement from one site (e.g., a nursery) to the deployment site; or through planting or seeding designed to meet resource management objectives or obligations.

Ecosite

Ecological unit that develops under similar environmental influences (climate, moisture, and nutrient regime). An ecosite is a group of one or more ecosite phases that occur within the same portion of the edatope (e.g., lichen ecosite). Ecosite, in this classification system, is a functional unit defined by moisture and nutrient regime. It is not tied to specific landforms or plant communities as in other systems, but is based on the combined interaction of biophysical factors that together dictate the availability of moisture and nutrients for plant growth. Thus, ecosites are different in their moisture regime and/or nutrient regime.

Point Collection

Registerable Stream I material collected within area and elevation limits defined in FGRMS Appendix 4. Compliance enables application for variance.

Propagule

Any of various usually vegetative portions of a plant, such as a bud or other offshoot, that aid in dispersal of the species and from which a new individual may develop. In asexual reproduction, a propagule may be a woody, semi-hardwood, or softwood cutting, leaf section, or any number of other plant parts. In sexual reproduction, a propagule is a seed or spore. In micropropagation, a type of asexual reproduction, any part of the plant may be used, though it is usually a highly meristematic part such as root and stem ends or buds.

Registration

Process that allows a seed or vegetative lot to be used for deployment within its CPP region or seed zone. Only Stream I and Stream 2 materials can be registered. Registration may be restricted or unrestricted. A registered seed or vegetative lot is one that has completed the registration process.

Seed Orchard

A stand of trees, usually several hundred to several thousand in number, established and managed primarily for early and abundant production of seed for deployment. Trees in the orchard are derived and propagated from selected parent trees, usually by grafting or by seed.

Seed Zone

A geographic area, defined on the basis of ecological characteristics and genetic information, within which Stream I material meeting unrestricted registration requirements may be collected and freely deployed. Seed zones may apply to group of species, or species-specific seed zones may be developed.

Seed Zone Collection

Registerable Stream I material collected within a single seed zone, not otherwise subject to constraints of area or elevation range; not eligible for variance.

Shrub

A woody perennial plant differing from a tree by its low stature and by generally producing several basal shoots instead of a single trunk.

Species-specific Seed Zone

A seed zone, delineated for a single species on the basis of adaptation as assessed from genetic trials, within which Stream I material may be collected and freely deployed.

Stoolbed

An aggregation of closely spaced stumps, or stools, managed for the production of vegetative sprouts (whips). Harvested whips are used for operational planting stock and can be pre-rooted prior to deployment.

Stream I Material

Seed or vegetative material collected from wild or artificially regenerated stands of native species within a given seed zone, having restricted or unrestricted registration for deployment in that seed zone.

7.2 Acronyms

BMP	Best Management Practices
EC	Electrical Conductivity
EPEA	*Environmental Protection and Enhancement Act*
ESRD	Alberta Environment and Sustainable Resource Development

FGRMS	Alberta Forest Genetic Resource Management and Conservation Standards
OSRIN	Oil Sands Research and Information Network
OSVC	Oil Sands Vegetation Co-operative
SEE	School of Energy and the Environment
TEK	Traditional Ecological Knowledge
TFA	Temporary Field Authorization

APPENDIX 1: Workshop Agenda

0830	Registration, coffee, muffins
0850	Welcome, rules, safety
0900	Session 1: Regulatory Requirements and Policies – Overview: Gillian Donald (Donald Functional & Applied Ecology Inc.)
	Session 1 Discussion How do current regulatory requirements and policies encourage use of shrubs in reclamation? How do current regulatory requirements and policies impede use of shrubs?
1010	Coffee
1030	Session 2: Current State of Knowledge – Overview: Jay Woosaree (Alberta Innovates – Technology Futures)
	Session 2 Discussion Do we know which shrubs to use and why? Do we know how they can be collected, stored, grown and seeded/planted? Can we get the shrubs we need when we need them? Do we know how shrubs perform in reclamation setting(s)? Do we know where (from whom) to obtain information?
1200	LUNCH (provided)
1300	Session 3: Knowledge Gaps and Policy Needs – Overview: Rob Vassov (Shell)
	Session 3 Discussion What constitutes "successful shrub reclamation"? What research is required into shrub species selection? What research is required to collect, store, grow and seed/plant shrubs? What scale of research is required – lab, plot, large-scale demonstration? What policies are required or need to be updated?
1400	Coffee
1420	Session 4: Next Steps – Amanda Schoonmaker (NAIT) Who should do what? When should it happen? What will it cost?
1500	Summary and Closure

APPENDIX 2: Workshop Attendees

Name	Organization
Alan Pollock	Northern Alberta Institute of Technology
Amanda Schoonmaker	Northern Alberta Institute of Technology
Ann Smreciu	Wild Rose Consulting
Anne Mcintosh	Alberta Biodiversity Monitoring Institute
Barbara Thomas	Alberta-Pacific Forest Industries Inc.
Bin Xu	Northern Alberta Institute of Technology
Brian Eaton	Alberta Innovates – Technology Futures
Craig Farden	Syncrude
Dale Doram	Golder
Dan McCurdy	Boreal Horticultural Services
Dave Downing	Consultant
Dean MacKenzie	Navus
Debbie Everts	Grumpy's Greenhouses & Gardens Ltd.
Deogratias Rweyongeza	Alberta Tree Improvement and Seed Centre
Donna Palmarek	Alberta Tree Improvement and Seed Centre
Ellen Macdonald	University of Alberta
Eric Girard	Syncrude
Erin Fraser	Alberta Environment and Sustainable Resource Development
Gillian Donald	Cumulative Environmental Management Association / Donald Functional & Applied Ecology Inc.
Glen Goodwill	PRT nursery
Ira Sherr	Canadian Natural Resources Limited
Jay Woosaree	Alberta Innovates – Technology Futures
Jill Kaufman	Millennium
Ken Greenway	Alberta Environment and Sustainable Resource Development
Ken Wright	BowPoint Nursery
Kevin Renkema	Navus

Name	Organization
Kim Gould	Wild Rose Consulting
Larry Lafleur	Smoky Lake Nursery
Lelaynia Cox	Suncor
Leonard Barnhardt	Alberta Environment and Sustainable Resource Development / Alberta Tree Improvement and Seed Centre
Lindsay Robb	Alberta Tree Improvement and Seed Centre
Lionel Borges	Stantec
Lori Neufeld	Imperial
Mark Dewey	Northern Alberta Institute of Technology
Markus Thormann	WorleyParsons
Marshall McKenzie	Alberta Innovates – Technology Futures
Martin Blank	Canadian Forest Service
Neil McAlpine	Land User Knowledge Network
Pam Wright	Bow Point Nursery
Robert Albright	Conoco
Robert Vassov	Shell
Scott Formaniuk	Smoky Lake Nursery
Shauna-Lee Chai	Alberta Innovates – Technology Futures
Simon Landhausser	University of Alberta
Surya Acharya	Agriculture Canada
Tim Vinge	Alberta Environment and Sustainable Resource Development
Vic Lieffers	University of Alberta
Yuguang Bai	University of Saskatchewan

APPENDIX 3: Session Presentations and Questions

The following PowerPoint slides were presented by:

- Chris Powter, Oil Sands Research and Information Network – introductory remarks and context setting
- Gillian Donald, Donald Functional & Applied Ecology Inc. – current regulations and guidelines
- Eric Girard, Syncrude Canada Ltd. – application of the rules in an industry context
- Jay Woosaree, Alberta Innovates – Technology Futures – overview of early shrub work
- Rob Vassov, Shell – ways to look at information gaps during the discussions
- Amanda Schoonmaker, Northern Alberta Institute of Technology – summary of key points from current knowledge and knowledge gaps sessions as context for next steps

Future of Shrubs in Oil Sands Reclamation

Oil Sands Research and Information Network
School of Energy and the Environment
University of Alberta

OSRIN Oil Sands Research and Information Network

www.osrin.ualberta.ca

http://osemb.cemaonline.ca/rrdcSearch.aspx

Welcome to 2nd Shrubs Workshop!

1978 Workshop to **discuss the state of knowledge regarding shrub propagation, outplanting techniques and species selection**. Twenty eight people from provincial and federal government agencies, industry, nurseries and academia took part.

In short, we would like to come away from this meeting with ***a clearer understanding of where we stand and where we have to go in shrub research for reclamation***.

OSRIN *Creating and Sharing Knowledge* 2

Why Shrubs and Why Now?

- Importance of shrubs
  - Wildlife
  - Traditional use
- Increasing emphasis on ecosystem reclamation
  - Diversity – more than just trees
  - Community structure
  - Ecological function and processes
- Increasing, but unconsolidated, information

Steering Committee

- Amanda Schoonmaker – NAIT
- Ann Smreciu – Wild Rose Consulting
- Brett Purdy – Alberta Innovates – Energy and Environment Solutions
- Gillian Donald – Donald Functional & Applied Ecology Inc.
- Jay Woosaree – Alberta Innovates – Technology Futures
- Lori Neufeld – Imperial Oil
- Robert Vassov – Shell
- Simon Landhausser – University of Alberta
- Tim Vinge – Alberta Environment and Sustainable Resource Development

Workshop Structure and Product

- Session 1: Regulatory Requirements and Policies
- Session 2: Current State of Knowledge
- Session 3: Knowledge Gaps and Policy Needs
- Session 4: Next Steps

- Product – Workshop summary report released by OSRIN
  - Unless otherwise requested we will be including participant names and orgs in report

Process

- Short intro to subject by Session Chair
- Primary focus is group discussions
  - Appoint a recorder – your detailed flipchart notes will form the basis of the Workshop Summary!
  - Session questions are a guide – it's OK to stray (a bit)
- Reporting
  - **Tables** will report on **two key points** raised in each session
  - Short open discussion follows

Arctostaphylos uva-ursi plant in its natural habitat

Safety Moment

- Fire exits
- Smoking
- Washrooms

Cornus sericea berries.

Juniperus communis spreading growth form.

- Breaks and lunch
- Recycle nametags please

Session 1: Regulatory
Chair – Gillian Donald

Lonicera caerulea shrub showing upright nature.

CURRENT REGULATIONS OR GUIDELINES

TERMS AND CONDITIONS ATTACHED TO OIL SANDS MINE APPROVAL

PART 6: LAND RECLAMATION GENERAL

6.1.7 "The approval holder shall revegetate disturbed land to target the establishment of a self-sustaining, locally common, boreal forest integrated with the surrounding area". Refer to:

- Guidelines for reclamation to Forest Vegetation in the Athabasca Oil Sands Region (Dec 2009) Refer to:
- The Native Plant Revegetation Guidelines for Alberta (Feb. 2001)

Other:

- Guidelines for Industrial Development Sites, Revegetation Using Native Plant Materials (Sept 2003)
- Most, if not all revegetation specialists are regulated professionals and have to use due diligence

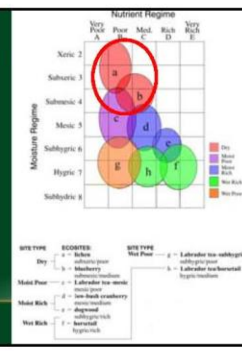
GOAL OF *GUIDELINES FOR RECLAMATION TO FOREST VEGETATION IN THE ATHABASCA OIL SANDS REGION (2ND ED)*

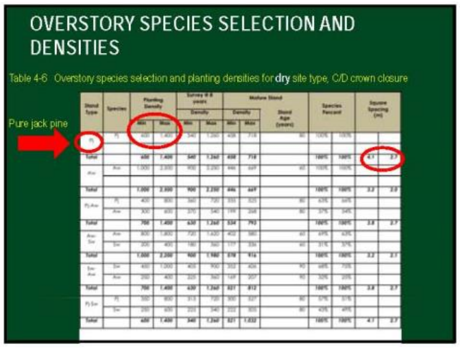
to provide guidance on re-establishing the vegetation component of upland ecosystems on reclaimed landscapes, and on evaluating the success of this re-establishment.

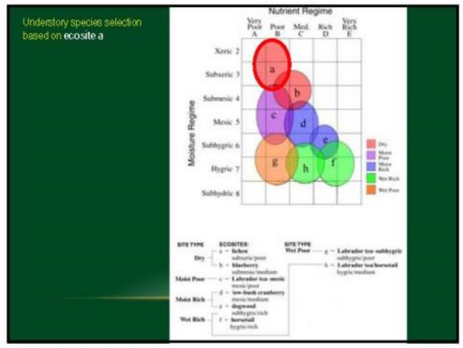
REVEGETATION PLANNING EXAMPLE:
- TARGET ECOSITE A, COMMERCIAL FOREST END LAND-USE

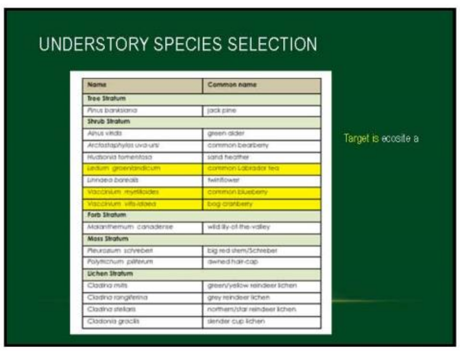
1. Use ecosite/site type approach (Figure 2-1)
2. Determine soil moisture regime and soil nutrient regime
3. Refer to Figure 3-2 to determine position on edatopic grid
4. Declare target ecosite (understory) and site type (overstory)
5. Declare target end land-use

Overstory species selection based on site type: Dry

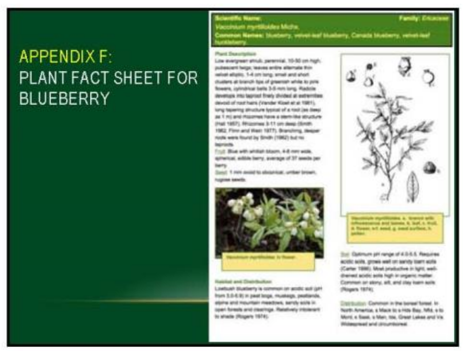


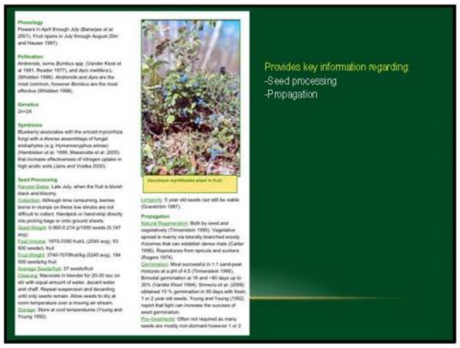


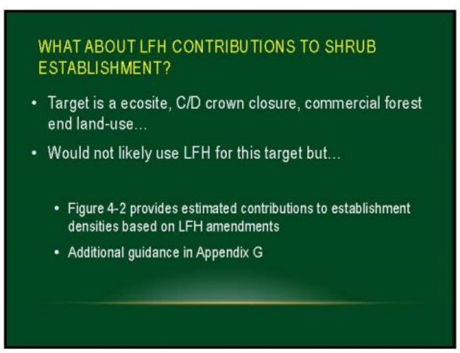


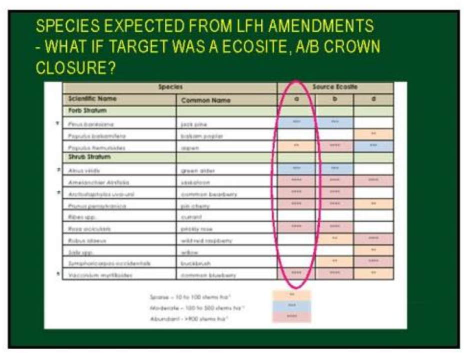


Name	Common name
Tree Stratum	
Pinus banksiana	jack pine
Shrub Stratum	
Alnus viridis	green alder
Arctostaphylos uva-ursi	common bearberry
Hudsonia tomentosa	sand heather
Ledum groenlandicum	common Labrador tea
Linnaea borealis	twinflower
Vaccinium myrtilloides	common blueberry
Vaccinium vitis-idaea	bog cranberry
Forb Stratum	
Maianthemum canadense	wild lily-of-the-valley
Moss Stratum	
Pleurozium schreberi	big red stem/Schreber
Polytrichum piliferum	awned hair-cap
Lichen Stratum	
Cladina mitis	green/yellow reindeer lichen
Cladina rangiferina	grey reindeer lichen
Cladina stellaris	northern/star reindeer lichen
Cladonia gracilis	slender cup lichen









	Species		Source Ecosite		
	Scientific Name	Common Name	a	b	d
	Forb Stratum				
*	Pinus banksiana	jack pine	***	***	
	Populus balsamifera	balsam poplar			**
	Populus tremuloides	aspen	**	****	***
	Shrub Stratum				
*	Alnus viridis	green alder	***	***	
	Amelanchier alnifolia	saskatoon	****	****	****
*	Arctostaphylos uva-ursi	common bearberry	****	****	
	Prunus pensylvanica	pin cherry	****	****	**
	Ribes spp.	currant			
	Rosa acicularis	prickly rose	****	****	
	Rubus idaeus	wild red raspberry		**	****
	Salix spp.	willow			**
	Symphoricarpos occidentalis	buckbrush		**	****
*	Vaccinium myrtilloides	common blueberry	****	****	**

Sparse – 10 to 100 stems ha^{-1} **
Moderate – 100 to 500 stems ha^{-1} ***
Abundant - >900 stems ha^{-1} ****

Reality of the Athabasca oil sand region:

- 141,967ha of land EPEA approved for disturbance for oil sands mining (N-E regions)
- Include ~15,500 ha targeted to be wetland.

• The scope for Syncrude:

- Syncrude is one of the largest operator beside Suncor.
- We reclaimed 3,186 ha in the last 30 years and has a total footprint of 25,858 ha for our two mines (2011 numbers)
- Syncrude expect through progressive reclamation to reclaim an average of ~450 ha/year for the next 23 years so about 225,000 shrubs/year.
  - Using ~18 species in 2 seed zones.
  - We average at 13,000 shrubs/species/year. (Relatively small number when looking at the size of our program)

REGULATION OVERVIEW:

- Collect and deploy as close as possible to the disturbed site,
- Collect and deploy within the same Natural Region and/or Sub-region,
- Collection guidelines (from The Native Plant Revegetation Guidelines for Alberta):
  - Collecting first from areas intended for development or disturbance.
  - Avoiding rare or fragile habitats.
  - Leaving at least 50% of the seed in place to allow natural propagation, and to provide food for insects, birds and small mammals.
  - Collecting minimal amounts (from no more than 10% of the plants) in areas that may be subjected to further collecting by the general public or where grazing reduces natural regeneration.
  - Leave an area to rest for at least two years between collections (longer periods of time may be necessary for some species and locations).

THEN IN 2011:

- On a voluntary base, OSVC* members followed the Alberta Forest Genetic Resource Management and Conservation Standards (developed for commercial trees).
  - Let's use this as a baseline for discussion:

*OSVC = COSIA Northern Athabasca Oil Sands Vegetation Cooperative

ALBERTA FOREST GENETIC RESOURCE MANAGEMENT AND CONSERVATION STANDARDS

Table of Requirements for Point Collections of Stream 1 Material

Material category	*Stream 1 material*[1]	Minimum trees per collection for *unrestricted registration*	Range of trees per collection eligible for *restricted registration*[2]	Maximum elevation range of trees collected from	Maximum area from which collection is made
A	All seedlot collections except aspen and balsam poplar	30	20-29	100 m	2 km radius
B	Aspen and balsam poplar seedlot collections	10 (well-spaced clones)[3]	7-9 (well spaced clones)[3]	100 m	5 km radius
C	Vegetative lots (deployed without serial propagation)	75[4]	N/A	100 m	5 km radius
D	Vegetative lots (serial propagation before *deployment*)	120[4]	75-119	100 m	5 km radius

[1] Proponents are encouraged to make *Stream 1* collections from *wild* stands within *in situ* conservation areas (see Standard 20.2) and adjoining areas to ensure that *wild* genetic resources are preserved.
[2] Collections from trees fewer than listed in this column may be stored "pending registration" (see Appendix 2) and will only be registerable where combined to meet unrestricted or restricted registration requirements.
[3] Must be collected from clones separated by at minimum of 500 m.
[4] Must be collected from trees separated by at least 10 m.

- We target for Point collection and unrestricted registration due to the nature of reclamation.
- Notion of seed zone.

Deployment in the context

- For seed zones CM2.1, CM 2.2, CM 2.4 and AP 1.1 we have the ability to deploy 25 M of seedlings/lot.
- if 10 species of shrubs are used at 500 Stems/ha leading to average of 50 stems per ha/spp.
- We have the potential to use half the deployment limit of one seed lot to reclaimed Syncrude disturbed footprint (two mines) for one specie of shrub...

Appendix 14. Stream 1 Seedling and Vegetative Propagule Lot Deployment Limit by Seed Zone

See Standards 11.3, 18.2.3 and 18.2.4.

Size Category	Seed Zone Area (ha)[1]	Maximum Number Deployable per Lot[2]		Approximate kg Seed[3]			Approximate Coverage in ha	
		Seedlings	Vegetative Propagules	Sw	Aw	Pl	Seedlings	Vegetative Propagules
1	> 1 million	25 million	20 million	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	500,000 to 1 million	20 million	16 million	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	100,000 to 500,000	15 million	12 million	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	< 100,000	10 million	8 million	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Syncrude case for 2012: The nightmare!

- In 2012 over 50 % of all shrub planted in the Boreal Region were planted at Syncrude.
- In 2012 Syncrude planted approximately half of all shrubs planted in the oil sands region:
  - 6 species of trees (829,440 trees),
  - 11 species of shrubs (124, 050); an average of 11,200 seedlings/species
  - 69 seed lots to manage! (excluding seed lot merged prior to any transaction)
  - Seed source: 4 seed zones
  - Deployment in 2 seed zones
  - 27 Planting blocks: 3 ecosites: 662 ha total. An average of 25 ha/block
  - Excluding bioengineering: 164 fascine 0.3m diameter and 4.25m long, 100 live stakes of 0.75 m (~5000 stems of Poplar and Willows)
- In 2012 we notified AESRD that we will not follow the standards (for shrubs only) due to timing and lack of resource all across the chain.
- 2014-15 program: 54 seed lots, 21 species, 12 variance requests for a total number of 500,000 seedlings. Several seed lot can only grow less than 500 plants!

-Each color is a different species.
-4 seed zones
- OSVC only have collected:

25 lots in 2009
90 lots in 2010
87 lots in 2011
85 lots in 2012
71 lots in 2013

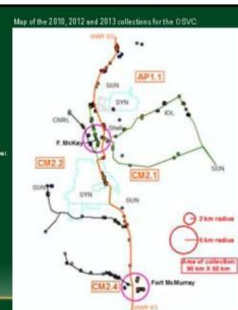
Total: 358 lots

Reminder: OSVC collections are often split between share holders multiplying the seed lots and paperwork by a factor of 5 for withdrawal.

Elevation:
-CM 2.2: 540m (power road) down to 230m Fort McKay (310m delta)
-CM 2.1: 275 to 430 (155m delta)
-CM 2.4: 250-350 (100m)
-AP 1.1: 290-300 (10 M)

-All deployment within a 50 km radius in 3 zones

Map of the 2010, 2012 and 2013 collections for the OSVC:



Limitations – Find the big patches!

- The requirement:
  - a minimum number of plants/clones per point collection (clonal and non-clonal)
  - a small collection radius (2 or 5 km) for a single point collection
  - keeping in mind we leaving at least 50% of the berries/seed behind
  - 100m elevation range within the same sub-region
  - Follow administrative seed zones boundaries
    - We deal with 3 seed zones within the same natural sub-regions in 50km radius
  - Seed testing

Limitation - Find the big patches!

- This impacts us by:
  - A. difficulty to form an unrestricted seed lot (rare),
  - B. getting a small volume of seed per lots
    - Shrubs are generally sparse,
    - growing in clumps distributed in the landscape in specific ecosites
    - subject to productivity cycles
    - Often associated with disturbances and vulnerable (genetic pool?),
    - Patches are not always accessible for harvest due to:
      - the environment (abundant fens/bogs in CM),
      - safety reasons
      - land ownership
    - Need easy accessibility is key for an effective collection. It helps:
      - collect seed at their optimum, cover several seed zones,
      - beat the wildlife to it, utilized the limited resources, and
      - and to maintain the viability of the seed to its maximum
  - C. having to deal with large number of seed lots to deal with.
    - Lead to huge administrational demand all along the chain.
  - D. some seed lots are so small that germination tests would deplete them.

Limitations – Too small of a Jobs!

- The requirement of having:
  - a minimum number of plants/clones per collection site
  - lack flexibility in the Standards for small collection with close proximity deployment
  - for vegetative and whole plant the Standard offer 5 km freedom (not for seed)
- This impacts us by:
  - A. limiting us to do small collection on areas to be disturbed with localized deployment.
    - The rarer/sparser is a plant or a local plant communities, the more difficult it is to follow the standards to the letter, which seems counter productive in our effort to establish biodiversity
  - B. limiting the utilization of locally adapted genetic
  - C. limiting our ability to be opportunistic, respond to local requests for small scale initiative.
    - Land to be disturbed may have interesting plants with seed, propagules or whole stems to salvage. (May take the shape of a request from a stakeholders leading to possible public image impact).

LIMITATION - TFA (TEMPORARY FIELD AUTHORIZATION):

- Appendix G of the Native plant revegetation guidelines for Alberta states:

"On public land, a Temporary Letter of Authority (TFA), with conditions, is required.

- Contact the local Public Lands office in the White (settled) Area or the Forest District Office in the Green (forested) Area.
- A plan is submitted to the appropriate agency
  - detailing the area to be harvested,
  - method of harvesting,
  - timing of harvesting,
  - and the target species.
  - After harvesting, the proponent submits a report to the appropriate field office identifying the actual areas harvested (on a map) and the approximate yield/volume of seed/plant parts".
- This is an additional formality, often challenging when conditions change, new productive patches are found or if species become available during the harvest season (opportunistic based on natural occurrence).
- Note that most seed collections are non-destructive

LIMITATION – INDUSTRY /RESOURCES

- Regulation that encourage large numbers of seed lots with little amount of seed and administrative demand may sterilize resources:
  - Seed collection is seasonal and influenced by natural cycles (some years: no seeds are available). It requires seasonal crews to respond to the demand. We have to optimized they ability to do their work and collect the largest amount of seed from as many species available possible for most seed zones required.
  - Seed extraction plants have to process seed in a timely matter to insure the best seed quality possible.
  - Quick turn around required for administration in order to use seed same collection year.
  - Greenhouses are at over capacity. Large forestry customers are being turn down. Reclamation using several species and seed lots, requires tremendous amount of resources for a really small market (<7% for some greenhouses). This is in an industry importing their workforce from foreign countries.
  - Shipping and tree planting using several small lots is a source of inefficiency and errors. When trees are deliver with leaves on, they have to be planted quickly to insure their survival.
  - Strict, complex or resource demanding regulations may lead to streamlining shrub collection and deployment by targeting abundant, species easy to collect in large numbers, leading to a loss in the total biodiversity.

Our practices influence the genetic pool!

- It is important to remember for genetic biodiversity that:
  - the practice of progressive reclamation throughout time and geographically allows for relatively small and spread out planting blocks every years.
  - we practice small and frequent collections locally,
  - reclamation is taking place at close proximity of the natural setting allowing to be supplemented by natural sources (donor soil, wildlife or seed propagation)
  - shrub establishment is to be judged on its survival not its productivity. (Productivity is an important criteria for the creation of seed zones not as much for the survival)

Key points:

- Challenges of the seed collection (growing habits, access, land ownership), need large collection radius
- Need to be able to collect relatively large seed lots (not 25M or 200, but in the 0.5 M).
- Need to minimize the amount of resources sterilized in the administration process
  - Registration, variance, deployment, TFA, greenhouse mgt, tracking, and seed zones limits
    - Most of this can be achieved with the ability to increase seed lots sizes
- The ability to be opportunist or have localized small scale collection and deployment (locally adapted genetic):
  - Standards propose 5km for plants and cuttings: it is not enough for most leases.
- Our practice of progressive reclamation allow to help the use of genetic material adapted to the region.

RECOMMENDATIONS FOR DISCUSSION

- Need to increase the size of the seed lots by:
  - Allowing larger radius to form a point collection (15 to 20 km radius)
  - Instead of rigid seed zones, the use deployment radius within a natural region associated with an elevation
    - 80 to 100 km radius for a seed lot would probably help with all aspect (genetic and operational)
  - Elevation increase from 100m to at least 150 to 250m in the same natural sub-region.
- Exemption of the standards (trees and shrubs) if collection and deployment is within the same lease limits (with the addition of a 2 to 5 km buffer outside the lease limit to have access to native forest). After all, soil containing propagules and seeds already travels within the lease limits. (two objectives: promote localized genetic movement and support local initiative to save plants to be destroyed).
- BMPs managed by regulated professional may be an incentive to support biodiversity while addressing most of the concerns without adding new, complex regulations.
- Streamline the requirement for TFA when it is a non-destructive collection.

OVERALL

- It is a well established fact that operators have as a priority to re-establish sustainable biodiversity in the reclaimed landscape. Past impressive accomplishments are there to prove it.
- As Revegetation professionals we recognize the need for genetic risk management for shrubs in Alberta even if some of us already have to comply with guidelines link to our operating approvals.
- Our experience as operators tells us that having a good balance between the need for policies/regulations and our ability to execute them is key for success. We observed that trying to implement un-adapted Standards for shrubs requires too much resources and administration and limits our ability to make a difference in reclaiming the land.
- During the development of these guidelines or policies we have to keep in mind the end goal of biodiversity. Strict regulations and administrative burden may limit the ability of the regulated professional to "create" a diverse and resilient plant community.

Picture of Syncrude Gateway hill trail: non certified reclamation

Session 1: Regulatory
Chair – Gillian Donald
Reporting – Tables 1, 2

- How do current regulatory requirements and policies encourage use of shrubs in reclamation?
- How do current regulatory requirements and policies impede use of shrubs?

Session 2: Current Knowledge
Chair – Jay Woosaree

Shrub Utilization

- Greatest use of shrubs throughout the world has been for:
  - Shelter belt to control soil erosion
  - Fodder plants for livestock
  - Landscape planting
  - Use by all types of wildlife
  - Food
  - Spiritual & beauty products, bioproducts

- Great range of adaptation from high mountain elevations to the lowest, from the foothills to the driest region, where many species would not even grow

- Genetics and adaptation (diversity and performance)
- Shrub physiology (shrubs response to stresses such salinity, drought)
- Regeneration and establishment (establishment in diverse areas/landforms)
- Role in ecosystem processes and function

Session 2: Current Knowledge
Chair – Jay Woosaree
Reporting – Tables 3, 4, 5

- Do we know which shrubs to use and why?
- Do we know how they can be collected, stored, grown and seeded/planted?
- Can we get the shrubs we need when we need them?
- Do we know how shrubs perform in reclamation setting(s)?
- Do we know where (from whom) to obtain information?

Session 3: Knowledge Gaps
Chair – Rob Vassov
Reporting – Tables 6, 7, 8

- What constitutes "successful shrub reclamation"?
- What research is required into shrub species selection?
- What research is required to collect, store, grow and seed/plant shrubs?
- What scale of research is required – lab, plot, large-scale demonstration?
- What policies are required or need to be updated?

Session 4: Next steps
Chair – Amanda Schoonmaker

- Some thoughts based on discussions today
- There is information and knowledge though not complete consensus on this.
  - Can we better pool all of the information into a working body of knowledge?
- There are significant knowledge gaps that remain in terms of shrub propagation and particularly out-planting field performance.
  - Is there a way to better coordinate monitoring across companies, research organizations etc.?

Session 4: Next steps
Chair – Amanda Schoonmaker
Reporting – Tables 9, 10

- Who should do what?
- When should it happen?
- What will it cost?

Rhododendron groenlandicum inflorescence.

APPENDIX 4: Session 1 Regulatory Requirements and Policies Notes

The following regulatory requirements and policies were identified as supporting or encouraging use of shrubs:

- EPEA approval requirements

> The following are taken from the Total approval (Alberta Environment, 2011. Construction, operation and reclamation of the Joslyn North Oil Sands processing Plant and Associated Mines (Leases 24, 452 and 700). Alberta Environment, Edmonton, Alberta. 75 pp. http://envext02.env.gov.ab.ca/pdf/00228044-00-00.pdf)
>
> 6.2.2 The approval holder shall revegetate disturbed land to target the establishment of self-sustaining, locally common boreal forest ecosystems, integrated with the surrounding area, unless otherwise authorized in writing by the Director.
>
> 6.2.8 The Mine Reclamation Plan referred to in subsection 6.2.6 shall address, at a minimum, the following: (g) vegetation, with consideration of the target ecosite phases and forest productivity, including reference to spatial and temporal vegetation sourcing; (l) land uses including traditional land use, recreation, commercial/industrial, miscellaneous, etc.;
>
> 6.3.26 The Revegetation Plan referred to in subsection 6.3.25 shall comply with the Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2009, as amended
>
> 6.3.30 The Forest Resource Plans referred to in subsection
>
> 6.3.29 shall include the following, unless otherwise authorized in writing by the Director: (d) a description of the processes and strategies that will be employed to ensure a reliable and timely supply of adapted reclamation propagules, sufficient to meet the requirements of the approved reclamation plans;
>
> 6.3.33 The approval holder shall: (d) comply with the requirements of the Alberta Forest Genetic Resource Management and Conservation Standards, Alberta Sustainable Resource Development, May 2009, as amended; and (e) comply with any Government of Alberta policy related to the deployment of propagules for use in reclamation;

- The approval goal of establishing a locally common boreal forest

> The following is taken from the Total approval:
>
> 6.2.1 The approval holder shall reclaim the land so that the reclaimed soils and landforms are capable of supporting self-sustaining, locally common boreal forest ecosystems, regardless of the end land use.

- Clarity on definition and use of the term "ecosite"; ecosite focus promotes selection and planting of appropriate shrub species based on reclaimed site characteristics

> The following is taken from the Total approval
>
> 1.1.2(v) "ecosite" means ecological units that develop under similar environmental influences (climate, moisture and nutrient regime). Ecosites are groups of one or more ecosite phases that occur within the same portion of the edatope (moisture/nutrient grid). Ecosite is a functional unit defined by the moisture and nutrient regime. It is not tied to specific landforms or plant communities, but is based on the combined interaction of biophysical factors that together dictate the availability of moisture and nutrients for plant growth. As defined in Field Guide to Ecosites of Northern Alberta, Beckingham and Archibald, 1996, as amended;

- Adaptable and flexible reclamation plans (Closure Plan and Reclamation Plan)
- Regulations do encourage shrub use and are prescriptive (but still flexible); broad goals allow for some interpretation
- Significant shift in emphasis over time from agronomic grass/legume mixes for erosion control to commercial forest species to ecological (whole forest) outcomes
- Encouragement to undertake progressive reclamation
- Increasing awareness of importance of ecological succession and reclamation trajectories in defining success
- Significant level of *strategic guidance* and increasing amount of *technical guidance*
- The Revegetation Manual (Alberta Environment, 2010. Guidelines for reclamation to forest vegetation in the Athabasca oil sands region, 2nd Edition. Prepared by the Terrestrial Subgroup of the Reclamation Working Group of the Cumulative Environmental Management Association, Fort McMurray, Alberta. 332 pp. http://environment.gov.ab.ca/info/library/8269.pdf) encourages the use of shrubs through the characteristic species ecosite tables
- The Revegetation Manual and the Best Management Practices (BMP) document (Alberta Environment and Water, 2012. Best management practices for conservation of reclamation materials in the mineable oil sands region of Alberta. Prepared by MacKenzie, D. for the Terrestrial Subgroup, Best Management Practices Task Group of the Reclamation Working Group of the Cumulative Environmental Management Association, Fort McMurray, Alberta. 161 pp. http://environment.gov.ab.ca/info/library/8431.pdf) promotes shrub reclamation

through preservation of shrub propagules in surface soils, especially LFH materials[3], and direct placement[4]

- The Alberta Forest Genetic Resource Management and Conservation Standards (FGRMS - http://srd.alberta.ca/LandsForests/ForestManagement/documents/FGRMS-AlbertaForestGeneticResourceManagementAndConservationStandards-May2009.pdf) apply to all vegetative material
- There are species specific collection standards and seed zones (clarity)
- There are no legislated requirements for composition / density but policy is determined by legislation and approvals (species selection, planting density)

Additional points that support use of shrubs included:

- The Oil Sands Vegetation Cooperative (OSVC) is collecting and storing seeds of a variety of tree and shrub species

One Table provided the following definition of *impede* for the purposes of the Workshop: anything that costs resources but has an unknown result

The following efficiency and effectiveness impediments were identified:

- There is excessive (and costly) administration associated with seed zones and seedlots (this applies to industry *and* government); a *logistical nightmare*
- Record keeping and TFA process a burden
- More flexibility is needed on variance requests – need to be able to move seedlots further (with good reasons)
- Seed zones are too small
- Seed zones that are split by geography (e.g., Athabasca River) create significant hurdles for oil sands operators that have sites on both sides of the river; suggest creating a new seed zone for the region to accommodate these special circumstances
- Animal dispersers and wind don't follow seed zone rules (is nature wrong?)

---

[3] For more on the value of LFH see Naeth, M.A., S.R. Wilkinson, D.D. Mackenzie, H.A. Archibald and C.B. Powter, 2013. Potential of LFH Mineral Soil Mixes for Land Reclamation in Alberta. OSRIN Report No. TR-35. 64 pp. http://hdl.handle.net/10402/era.31855

[4] One participant noted that a literal reading of the FGRMS seed movement rules would mean long haul direct placement would place the company out of compliance.

- Restrictive regulations limit potential seed lot size and therefore lead to excessive numbers of seedlots (combining seedlots is possible but then they can't be deployed outside of the seed zone)
- Rules don't allow collection from small areas to be disturbed by mining therefore valuable seed volumes and genetic material lost
- Sourcing standards regarding elevation (+/- 100 m) and distance need to be revised; need to test the assumed hypotheses about elevation, distance and latitude
- Need to make the system workable to meet the *practical* limitations (e.g., reclamation area plans change which could remove ability to use seed collected based on the original plan)
- FGRMS is meant for trees not shrubs; seed zones don't make sense for shrubs; need to adapt
- Some standards are defined by productivity, but what does this mean – biomass? diversity?

The following ecological impediments were identified:

- System needs to be flexible and responsive to the natural variability in seed production (e.g., pincherry has good years and very poor years)
- System encourages multiple collections over time from same large source area rather than encouraging more genetic diversity by allowing smaller collections from more sites
- The definition of ecosite in relation to the EPEA equivalent land capability goal needs to be redefined to recognize reclaimed ecosites (sites that are managed) and natural ecosites; ESRD, Public Lands, already has such a system for rangelands that recognizes different successional trajectories
- Can't build a climax community in year one
- Some shrub species are best deployed in later successional stages but the current rules incent immediate deployment of all species (e.g., lowbush cranberry needs shade and won't survive until there is an overstory – as a result we know *what* but not *when* to plant)

Looking at staged approaches to reclamation along the lines of successional stages is there the ability to use non-native shrubs to establish sites. Once established remove them from the system and move forward to the next reclamation stage.

- Current density rules (500 stems/ha) don't account for natural emergence / invasion therefore excessive planting is done (prickly rose was given as an example)
- There is a need to reconcile the site scale rules with the landscape and regional rules relative to genetic diversity
- Need more information on longevity of seeds and other propagules in soil stockpiles and methods to enhance their longevity

Additional non-regulatory impediments noted were:

- There are operational / tactical challenges throughout the system: collection (lots of stops) -> storage (lots of registration and testing required; the latter is especially a problem for small seed lots) -> withdrawal (planning withdrawal and variances) -> growing (lack of knowledge about viability, dormancy, propagation for some species; general lack of knowledge on optimizing treatments like fertilizer and temperature; general lack of knowledge about specialized treatments like smoke water and CO_2) -> deployment (tracked internally)
- Need a system that encourages preservation of genetic diversity / suitability but allows for more operationally sensible collections (e.g., point collections vs. seed zone collections)
- While supply of seed may not be an issue now, in the future there will be fewer undisturbed patches to harvest from
- Seedling production is geared for large lot consumers (e.g., forestry) rather than smaller lot consumers (e.g., oil sands)
- Some revegetation diversity goals are being driven by stakeholders rather than good science
- We have a relatively good understanding of shrub reclamation for *regular reclamation sites* (no inhibiting factors) for both early and late successional species but we are not as advanced for early successional stages in challenging sites and have little knowledge and experience with late successional species in challenging materials
- Lack of a *commodity trading structure* for exchange of reclamation materials (e.g., soils for direct placement to take advantage of live propagules) between operators; it is difficult to use all available freshly salvaged soil before seed viability declines
- The Mine Financial Security Program (Alberta Environment, 2011. Guide to the Mine Financial Security Program. Alberta Environment, Edmonton, Alberta. 62 pp. http://environment.alberta.ca/documents/MFSP_Guide_-_2011_03_30.pdf) requires operators to post an Outstanding Reclamation Deposit if reclamation is not

completed – since complete means vegetation planted, which includes shrubs, operators plant to reduce liability / security deposit even if it doesn’t make ecological sense

- The effect of climate change on future application of seed zones has not been addressed in the application of the regulations (particularly an issue for oil sands mines that have very long reclamation timelines)
- Need to seek information from other disciplines (especially forestry), grey literature, conferences and workshops, older research

APPENDIX 5: Session 2 Current State of Knowledge Notes

The following notes are organized based on group responses to the questions asked.

Do we know which shrubs to use and why?

- Yes, but there are conflicts between those that are easy to grow and the *characteristic species* in the Revegetation Manual
- We know *which* ones to use but maybe not *why*; current reclamation certification rules require x stems/ha and species doesn't matter so no incentive for diversity
- Selection depends on land use / objectives
- Need to match species to site conditions (e.g., moisture (Figure 2), flooding tolerance, shade tolerance, salinity tolerance)
    - Target appropriate genotypes when using cuttings

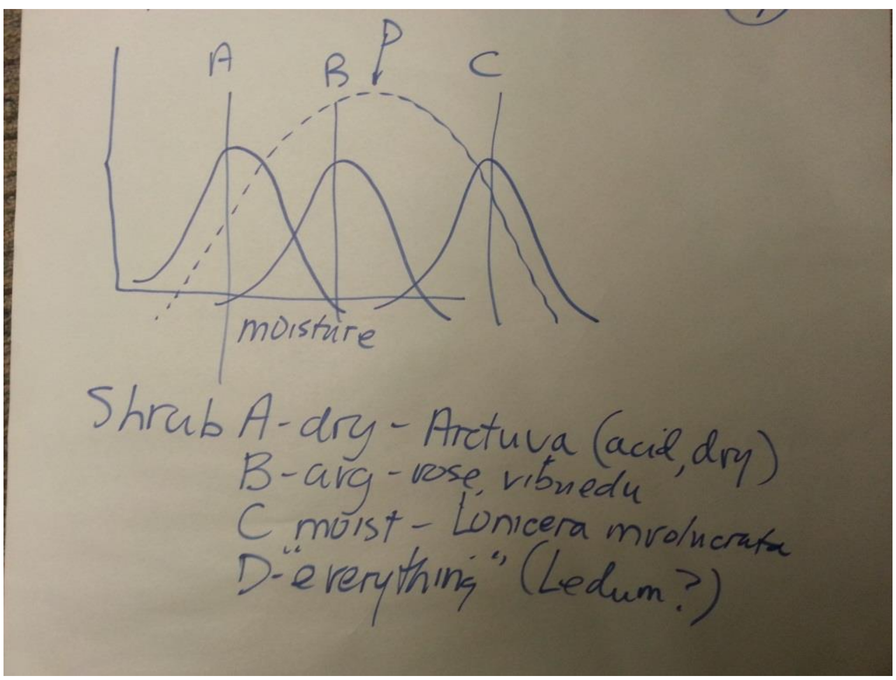


Figure 2. Matching species to site conditions

- There are some disconnects between short term goals (e.g., obscure line of sight) vs. long term goals (boreal forest ecosystem)

I would like to suggest the use of willows as nurse crops or 'place holders' in areas that are difficult to establish, kick starting the biological processes needed to fully establish these areas. This could possibly include native, non-native, hybrid, sterile (triploid) clones specifically suited for a particular purpose (contaminant removal/tolerance). The genetic variability is extremely high in willow and therefore could allow for their use in targeting specific issues.

- We have more and better knowledge for upland species than wetland species
- We have limited knowledge of shrubs for use in saline sites
- Are there rare or endangered shrub species we will need to use? Do they require different approach?
- Key characteristics for successful shrub reclamation are:
    - Will grow on reclaimed soils
    - Have sufficient ecological range (range of natural variability) to accommodate / tolerate site variability (e.g., soil chemistry, shade)
    - Are able to serve / provide ecological function
    - Establish quickly and provide microsite conditions for other plants
    - Reparative (e.g., nitrogen fixation)
    - Useful for wildlife
    - Produce berries / flowers over time to ensure the plants are self-sustaining
    - Easy to propagate, establish and regenerate
    - Early successional
    - Important for First Nations (if we know this)
- Shrubs need to be competitive with other vegetation (planted or volunteer) or you have to control competition to allow establishment / growth
- Need to understand reclaimed soil properties (now and what they will look like in future after soil genesis) to select appropriate species
- Need better understanding of species and successional stage to determine when to plant and what effects canopy height / closure will have on existing plantings; how do we get to the *target* along the successional pathway

Follow natural successional processes in selecting species – use pioneers as these are the ones that are designed to "reclaim" damaged ecosystems.

- Currently planting more conifers; may not reflect realistic successional patterns

Do we know how they can be collected, stored, grown and seeded/planted?

- Collection, storage and seeded / grown issues understood for 50% to 75% of species but some are very difficult to germinate and grow
- Collection well known (based on phenology); need continual harvests of seeds for banking; seed crops highly variable year to year and different species seed at different times making collection a time-consuming (and therefore expensive) task; access to sites when needed is often difficult
- Storage known for *orthodox* species; short-term storage known; less so for long term storage; viability highly variable, both spatially and temporally; overcoming dormancy can take long time therefore difficult to plan for field deployment; need time to test viability of seed batches
- Growing conditions known for many species but some still need lots of work
    - Vegetative production knowledge uncertain
    - Species knowledge varies by grower (expertise, experience, interest, market)
- Field establishment still being worked on
    - Planting densities based on trees – may not be appropriate for shrubs
    - Sometimes site preparation methods may reduce ability of shrubs to establish and grow
    - Responses to modified soils (e.g., pH, EC) unknown
    - Uncertainty around light planting regimes (shade)
    - Seeding success unknown
    - Plug survival rates unknown
    - Sequencing of planting unknown
- Most shrub work done with seeds as cuttings are too expensive
- Knowledge is species dependent
- Some knowledge being horded (proprietary) which impedes efficient accumulation of knowledge

Can we get the shrubs we need when we need them?

- No
    - Not produced commercially at volumes needed
    - Greenhouse space limited

- Requires good planning
    - Requests for production not planned; ad hoc at best
    - Need at least two years notice from collection to delivery (currently often one years or less); for even greater protection allow two years collection and two years growing
    - However there are obstacles to the best plans (e.g., fires, access restrictions to collection areas, poor seed crops)
    - Collection rules restrict options
    - Planning is required by industry to coordinate seed/seedling production, especially for *new* testing
- Knowledge gaps for storage and stratification limits forward planning ability
- Disconnect between operations side and reclamation side makes timeframes too short to order appropriate plants
- There needs to be a consistent demand year to year to support private growers
    - Need to define the species there is a consistent need for and those that will be more specialized / sporadic
    - May need to concentrate on a few species
- There is several years of seed stored now – helps ensure quicker availability of stock
- The availability and cost of land and production facilities (e.g., nurseries, orchards, stool beds) is prohibitive but could mitigate seed supply concerns; easier for trees because of ability to cooperate with forestry
- Available now but as reclamation areas ramp up sufficient numbers may be difficult to obtain

Do we know how shrubs perform in reclamation setting(s)?

- No
    - Minimal information available in reclamation settings
    - Lots of variations on *reclamation method* (soil, hydrology, landform, microsite, plant materials and handling) so difficult to understand success
    - May have general information (e.g., shrubs as a group) but not species specific
    - *Rhododendron* (*Ledum*) and *viburnum* are difficult to propagate and have low outplanting survival – they are late seral stage plants

- Yes; for some species (e.g., *Salix* and *Alnus* do well because they are pioneer species with wide adaptability and are easy to propagate in large quantities)
- We aren't tracking
  - Performance by seedlot or growing or seedling specifications (therefore hard to know what it was that resulted in success or failure)
  - Shrub growth or reproduction
  - Root/shoot ratios
  - Winter damage rates
  - Natural ingress / regeneration
- We monitor tree / shrub planting densities
- Monitoring protocols may not work for *clumping* species
- We have been planting shrubs for a long time but the ability to do a retrospective review of success may be hampered by confounding factors (e.g., changing reclamation soil prescriptions, changing species) and record keeping
  - Lots of operational knowledge but not published / shared – *grey knowledge*

Do we know where (from whom) to obtain information?

- Yes, lots of people (industry, regulators, researchers, academia, consultants, growers, First Nations – TEK)
- Yes, lots of sources
  - Revegetation Manual
  - Native Plant Revegetation Guidelines (Gerling, H.S., M.G. Willoughby, A. Schoepf, K.E. Tannas and C.A Tannas, 1996. A Guide to Using Native Plants on Disturbed Lands. Alberta Agriculture, Food and Rural Development and Alberta Environmental Protection, Edmonton, Alberta. 247 pp.)
  - Field Guides
  - Fact sheets in Revegetation Manual (now updated and available on OSRIN site - http://www.osrin.ualberta.ca/Resources/RevegSpeciesProfiles.aspx) for some species; problem lies with the species not covered
  - Fire Effects Information System (USDA) – Fischer, W.C. (compiler). The fire effects information system. United States Department of Agriculture, Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory, Missoula, Montana. http://www.fs.fed.us/database/feis/plants/index.html

- Bonner, F.T. and R.P Karrfalt, 2008. The woody plant seed manual. United States Department of Agriculture. Agriculture Handbook 727. http://www.uri.edu/cels/ceoc/documents/WoodyPlantSeedManual-Complete.pdf
  - Nurseries
  - Seed suppliers
  - Herbaria
  - Alberta Native Plant Council (Native Plant Source List http://www.anpc.ab.ca/assets/ANPC_2010_Native_Plant_Source_List.pdf)
  - Canadian Forest Service
  - Practitioners (need more info on laboratory and greenhouse studies and experiences)
  - Industry trials (new and historical – paper copies)
  - CEMA Long Term Plant Network
  - Extension services (e.g., FORREX - http://www.forrex.org/)
  - Google Scholar, Wikipedia
  - OSRIN and Oil Sands Environmental Management Bibliography (http://osemb.cemaonline.ca/rrdcSearch.aspx)
- Permaculture – integrated planning approach
- Need more information sharing amongst operators and with regulators, especially around field performance
  - Trial and error important sources (negative learnings as important as positive ones)
- Need to seek information from other disciplines (especially forestry, agriculture, horticulture, shelterbelts), mining experiences in other regions

Other observations:

- High variability between areas, seasons and years is a big problem for developing efficient protocols and practices
- More focus of resources and people is required towards specific questions
- Species-specific literature reviews needed
- Conservation of resources or offsets not often part of the discussion
- While it is helpful to have national and international source information we need to develop local / regional knowledge (e.g., specific protocols based on geography)

APPENDIX 6: Session 3 Knowledge Gaps and Policy Needs Notes

The following notes are organized based on the questions asked.

What constitutes "successful shrub reclamation"?

- Identified success characteristics
  - Presence
  - Survival
  - Growth
  - Biomass / density
  - Diversity of species / community composition
  - Natural morphology
  - Root system
  - Reproduction / reproductive capacity
  - Seed / vegetative dispersal
  - Forms part of *ecosite target*
  - Fulfilling ecological role
  - Providing wildlife habitat and food sources
  - Healthy / robust / resilient[5] (adapts to biotic and abiotic stressors)
  - Successional role / stage / trajectory
  - Natural mortality rates (or better) emulated on reclaimed land
  - Suitable to the site
  - Site stability / erosion control
  - Future persistence (stress, disease)
  - Absence of invasive species
  - Mature reclamation unrecognizable as previously disturbed
  - Meets social need / Aboriginal use

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[5] For more on resilience see

Pyper, M.P., C.B. Powter and T. Vinge, 2013. Summary of Resiliency of Reclaimed Boreal Forest Landscapes Seminar. OSRIN Report No. TR-30. 131 pp. http://hdl.handle.net/10402/era.30360

Welham, C., 2013. Factors Affecting Ecological Resilience of Reclaimed Oil Sands Uplands. OSRIN Report No. TR-34. 44 pp. http://hdl.handle.net/10402/era.31714

> Note that too much shrub cover could be a bad thing (may stagnate and prevent forest development).

- Answer is policy driven
    - Meets Revegetation Manual characteristic species table
    - Meets 2010 upstream oil and gas forest criteria http://environment.gov.ab.ca/info/library/8364.pdf
- Answer depends on scale – individual, plot, landscape
- Answer depends on timing (when to measure – after planting? 25 years later?)
- Answer depends on goal / target (what was pre-disturbance state)
    - Caribou
    - Obscuring line of sight
- Overall goal is to create a community structure that is typical of a boreal forest landscape
    - Reintroduction of *target species* with *proper density* in a particular *ecosite*
- Potential to use reference condition approach (benchmarks) to define spatial and temporal range of natural variability and use those as targets
- Knowledge about individual species success is important
- Problem is missing baseline history for shrub plantings

What research is required into shrub species selection?

- Summarize existing research on shrub ecology
    - Autecology and synecology
    - Response to canopy closure
    - Importance of pollination (are there methods to facilitate in the oil sands)
    - Where do species fit in successional pattern
- Document current practices (a manual?)(combine with how's it working project below)
    - Compile existing unwritten knowledge from experts / practitioners
- Assessment of why past plantings have succeeded or failed (did the approach lead to achievement of goals)

    - Inventory existing reclaimed sites
- Develop understanding of
    - Range of natural variability and expected trajectories
    - Genetic variation and plasticity
    - Present and future growing conditions and response to climate change
    - Impacts of site and microsite conditions for optimal growth
    - Effects of planting timing (season)
    - Effects of fertilization
    - Effects of light regimes / shading
    - Effects of mycorrhizal associations
    - Role of association / companion species (e.g., aspen and lowbush cranberry)
    - Tolerances to salinity
    - Effects of competition / crowding
    - Diseases and pathogens
    - What shrub resilience is
    - Natural seed dissemination (wind, animals, snow melt) / plant egress
- How to select appropriate species from the Revegetation Manual characteristic species table
    - Maybe focus on representative species from guilds rather than individual species
    - Focus on characteristics such as reproductive traits, ecological function, plant form, genetic makeup
    - Understand competition / dependence between species
- Important to understand both common species and lesser known species that may play an important ecological role
- Suitability for *problem sites*

> Most of the discussions that I heard for the day revolved around reclamation as it pertained to large scale landscape level issues and not a lot to do with problem (contaminated) sites. I am not sure if that was intentionally the scope of the event or just the direction the participants took it but I think there is a role for the use of shrubs, particularly willow, in these problem sites. You are probably aware of the work Canadian Forest Service is doing on salt tolerance of willows for shoreline stability of end pit lakes. It is showing promise and is progressing

to a field trial this coming year.

- Evaluate alternative seeding techniques (e.g., seed pucks work at Canadian Forest Service)
- Cost benefit analysis of shrub establishment options
  - Balance of effort and resources against outcome
  - Identify easy to work with species and difficult ones and allocate resources to get greatest improvement
- Use of aspen or other trees as biological indicators (Figure 3)
  - Plant as a nurse crop then evaluate growth (annual and total over 5 years), density, survival
  - Use tree growth patterns to reveal site moisture status, then determine shrub and other species planting options

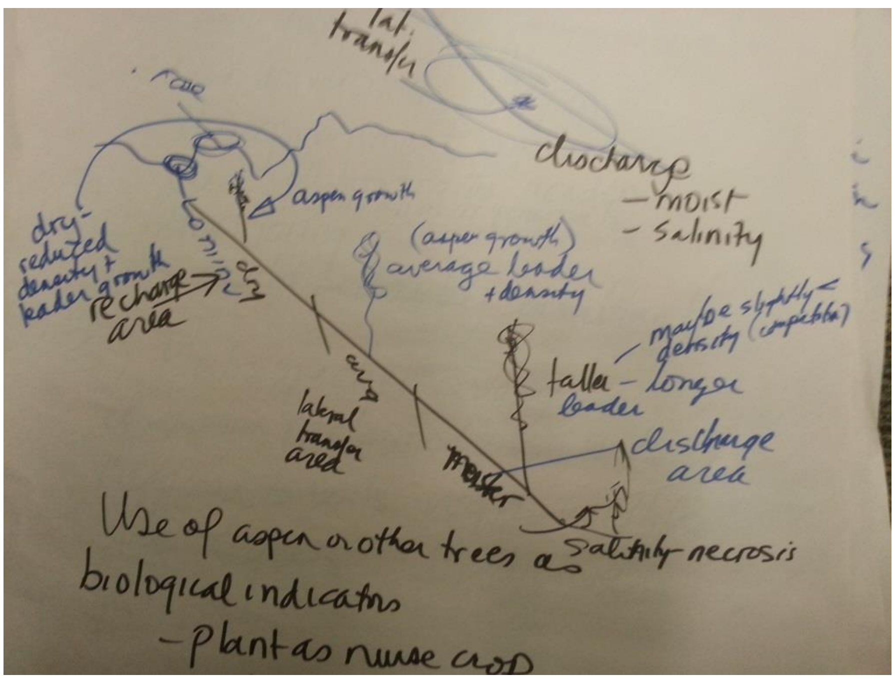

Figure 3. Aspen as moisture stress bioindicator.

What research is required to collect, store, grow and seed/plant shrubs?

- Species-specific
  - Focus on *problem species* (those that are hard to work with in any of the procedural categories)
  - Focus on *keystone* species
  - Focus on colonizing species
  - Need to clearly identify what the problem is we are trying to solve – is it seed availability, seed quality …)

Should prioritization of shrubs be considered in terms of what ecological role they are filling?

- Collecting
  - Timing is critical
  - Just do it!
  - Develop means to predict when seed crop will be ready to harvest
  - Train people how; especially how to pick seeds
  - Develop efficient way to collect and disperse plant material (e.g., tree tops)
- Storing of orthodox seeds require less effort
  - Seed longevity
- Need to develop criteria for evaluating seed quality (cut tests, germination tests)
- Germination and growth could use lots of research – need to know *fit for purpose*
  - Understand dormancy and how to break it
- *Viburnum* and *Shepherdia* storage and stratification not well understood
- Genetic variability across distance and elevation
  - Identify genetic markers
- Undertake progeny testing (reciprocal and common garden tests)
- Undertake breeding / hybridization work to select for desirable traits
- Propagation of rare plants
- Need Alberta oil sands-based Seed Collection, Preparation and Storage Manual

- Planting
  - Timing is critical, especially for late successional species
  - Stock and site characteristics are main success factors
  - Test stock types and sizes, root/shoot ratios
  - When to plant (spring / fall)
  - Hot planting vs. dormant
  - Appropriate stock handling methods
  - Appropriate planting densities
  - Need to know early mortality rates
  - Vegetative cuttings vs. seedlings; assessment of risks of each
  - When and how to plant alder
- Document experiences of people, trials / research, and operations
- Need to perfect methods for lowbush cranberry and buffaloberry
- Undertake forestry-type research on seedlings for every shrub species
- Develop understanding of orchard development and collection
  - Need (more) orchards
  - Beaked hazelnut is an example of a species that could be produced in seed / stooling bed orchards

What scale of research is required – lab, plot, large-scale demonstration?

- All scales needed (lab, greenhouse, plot, large scale demonstration, operational trials)
- Lab / greenhouse tests to pinpoint problems seen in field
- Lab / greenhouse to understand how and why of seed dormancy and germination
- Plot studies needed to assess success and phenology
- Demonstration scale
  - Need more – proof of concept / ability / success
  - See limited value
- Landscape level studies to understand interaction with variables (soils, climate, other species)
- Need long term studies

What policies are required or need to be updated?

- Revise rules and policies identified as impediments in Appendix 4
- Ensure the objective of policy is to gain approval (certification)
  - Should facilitate reclamation
  - Require hard targets with indicators
  - Must incorporate temporal aspect (when to measure)
- Establish policies that best minimize risk in the longer term (e.g., genetic maladaptation = species not suited to site, species interactions, ecosystem function)
- Establish policies that encourage cooperative work towards an accepted, common goal
- Adjust policies to be less prescriptive and instead focus on outcomes (ecological restoration / function, ecological processes established)
  - Currently more strategic guidance with lots of tactical impediments built in
- Test assumptions built into rules that soils = ecosite / revegetation needs; note that soils will be placed where land is available to maximize direct placement, not necessarily where they would match ecosite
- Clarify genetic resource management and biodiversity requirements in legislation and/or EPEA approvals
  - Biodiversity in particular is a regional, rather than minesite goal – rules need to encourage / incent operators to work together
- Add shrub research requirement into EPEA approvals (if not already covered by clauses related to participating in research groups like CEMA)
- Update Revegetation Manual to identify natural / reclaimed analogues and early successional species
- Update FGRMS collection and registration requirements
  - Especially challenges associated with small seedlots (testing to register can use up whole lot, tracking); encourage fewer, larger lots or relax requirements for registration
  - Adjust rules to fit shrubs
  - Use Regional Zones for seed (e.g., 50 km radius)
- Need to adjust policies to reflect potential climate change impacts on species choice and seed / plant movement (assisted migration)

Other comments

- Willows are crucial for pollinators
- Need to understand effects of fire, especially impacts to seed banks
- Commercial plant production business is competitive and cyclical, and reclamation isn’t main business driver

APPENDIX 7: Session 4 What's Next Notes

The following notes are organized based on a modified version of the original questions.

What should be done?

- Develop a roadmap and action plan for *shrub* knowledge
    - Start compiling information after Christmas
    - Develop review of gap analysis (6 to 12 months)
    - Prioritize research needs to allow funding of key items first
    - Develop action plan (identify committees / subcommittees to steward plan or use existing groups / structures)
    - Identify a *home* for the plan – CEMA? COSIA?
- Develop a roadmap and action plan for *vegetation* knowledge
    - Shrubs
    - Cover crops
    - Functionality
    - Succession
    - Seed storage
    - Growing plants
    - Reclaimed land classification
    - Establishment success
- Retrospective analysis of existing reclaimed sites
    - What has happened to soils, vegetation, wildlife over x years?
    - Include negative as well as positive results
    - Can we predict success based on this (build trajectories)?
- Focus on practical applications
- Need Best Management Practices on plant propagation
- Determine gaps (production, ecology, physiology, provenance, economics, social benefits) and move forward from there
- Need to start monitoring performance now (benchmark study)
    - Research and operational monitoring

- Need to develop monitoring protocol to be followed by everyone to ensure common and comparable data
    - Does Alberta Environmental Monitoring, Evaluation and Reporting Agency have a role?
- Training / education
    - Need to train seed collectors
    - Educate regulators
- Need to establish system to share existing and developing knowledge and coordinate future work[6]
    - Need to allocate funding to ensure this happens
    - OSRIN? CEMA? COSIA?
    - Meetings, workshops (schedule next one now, not wait for another 35 years!), publications
    - Inventory of *experts* who can / will share knowledge
    - Look at models like Northern Interior Vegetation Management Association, FORREX, Land User Knowledge Network
    - Establish a database or data warehouse – Clean Air Strategic Alliance model??
    - Need to work together for success
    - Need to identify and overcome barriers to sharing
- Need to evaluate shrub orchard options
    - Government should lead

Who should do it?

- Academic rigour needed to test hypotheses
    - Universities, colleges
    - Academic (journal) publication
- Responsibilities identified for all parties (industry, government, growers, consultants, regulators, and public – see Table 1)

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[6] For more on establishing a reclamation knowledge network see Alberta Innovates – Technology Futures, 2012. Investigating a Knowledge Exchange Network for the Reclamation Community. OSRIN Report No. TR-26. 42 pp. http://hdl.handle.net/10402/era.28407

- People / groups need to collaborate – this is long term, complex, multidisciplinary field-based research
- Industry
  - Onus should be on industry to carry out the research in a responsible and accountable manner – they are the ones who need the results
  - Promote strategic, coordinated and collaborative research
  - Identify priorities and needs so researchers can target proposals to meet needs
  - Provide access to sites and construct plots
  - Ensure industry-funded research results are accessible
- Oil Sands Vegetation Cooperative
  - Industry should ensure Cooperative remains effective and fully funded
  - Share information about collections with other operators and growers
  - Consider ways to have industry-wide collections rather than company-by-company and site-by-site – a true *cooperative*
  - Consider expanding role of Cooperative to include brokering exchange of live materials (planting stock) that becomes available when reclamation plans change – avoid losses
- Government
  - Updates policy (based on research and experience and consultation with affected parties); requires government to agree that policy needs updating because of conflicting expectations and inefficiencies
  - Government should finish Lower Athabasca Regional Plan to provide bigger picture in terms of land use and biodiversity goals
  - Government (with stakeholders) needs to clearly establish reclamation goals / targets / criteria so research can focus on expected outcomes; ever changing goals create significant inefficiencies for operators and researchers
  - Identify priorities and needs so researchers can target proposals to meet needs
- Consultants – focused problems, tasks, analyses
- Growers – ad hoc problems, greenhouse trials, provide plant materials for testing

When should it happen?

- Right now! Reclamation needs are going to increase significantly in about 10 years and will really ramp up by 2035 (maybe sooner for in-situ)

- Already under way for 30 years!
- Ideally close existing knowledge gap in 2 to five years
- Ongoing; need feedback loop from research to operations to research; adaptive management

What will it cost?

- Funding could be shared and duplication minimized
  - Academia, government, industry
  - Academic researchers can leverage funding grants
  - Note, not just an oil sands issue so funding from other industries could be sought
- Need adequate funding for experts (biologists, growers) provided by industry
  - Incentivize good performance through policy adjustments
- Realistically, lots! However investment will save time and $ in long run
  - Will be less with good coordination
  - How much is successful reclamation worth?
  - What is cost if we don't continue to develop new methods and technologies?
- Should be incorporated into the cost of doing business (social licence to operate)
- $40K OR $200K to $300K to develop roadmap
- Gap analysis likely cheapest part

Other comments

- Everyone benefits from successful reclamation so worth spending to improve chances of success

APPENDIX 8: 1978 Shrubs Workshop

In 1978 the Reclamation Research Technical Advisory Committee (RRTAC) convened a workshop to discuss the state of knowledge regarding shrub propagation, outplanting techniques and species selection (Ziemkiewicz et al. 1979). Twenty eight people from provincial and federal government agencies, industry, nurseries and academia took part.

The following introductory comments set the stage for break-out groups that discussed each of the three topics:

> We are now in the process of developing a comprehensive reclamation research program for the province. Certainly shrub research will have a place in this program, for while shrubs represent a small part of the reclamation picture they can fulfill specialized and critical roles in wildlife browse and habitat, windbreaks and aesthetics. Also, shrubs can be used as stabilizing materials on unstable slopes.
>
> One of the reasons for holding this workshop is that much of the information regarding shrub propagation, outplanting and selection has come about through years of experience and hasn't yet found its way into the literature. Several private and government organizations have investigated the use of shrubs and trees in reclamation. Also, a great deal of information on shrub propagation and selection has been acquired by government sponsored shelterbelt programs in Western Canada.
>
> We hope that by bringing these diverse groups together we can generate some mutually productive discussions. Moreover, I hope we arrive at some conclusions regarding the state of the art in shrub propagation, outplanting techniques and species selection. These conclusions will serve as the framework of our shrub research program and will allow us to avoid "reinventing the wheel". In short, we would like to come away from this meeting with a clearer understanding of where we stand and where we have to go in shrub research for reclamation.

In the area of propagation few major areas in need of research were apparent. Generally, adequate information or experience exists to propagate nearly all native shrubs of potential interest to reclamation. Further research in native shrubs propagation should concentrate on cataloguing existing knowledge and, in a few cases, refining known techniques.

With respect to propagation:

1. Propagation from seed
    a. Catalogue methods for breaking dormancy of Native Shrub Species. In a few cases methods will need refining.
    b. Develop standard methods for measuring seed quality.
    c. Catalogue methods for preventing damping-off in susceptible species. In some cases new methods and fungicides will have to be developed.

2. More efficient methods of propagation.

With respect to outplanting:

1. Guidelines are required for the proper field storage, handling and planting procedures for shrubs being supplied for reclamation.
2. Information should be made available on the procedures involved and usefulness of antitranspirants or similar material used at the nurseries on plants prior to shipping and planting.
3. Guidelines are required on native shrub selection and should include such criteria as:
   a. ease of collection and storage
   b. ease of propagation
   c. species selected should be adaptable to many sites and not site specific
   d. species role in desired end land use

   Other criteria to be evaluated on native shrubs is the root/top ratio, the root shear strength, moisture utilization, leaf size versus evapotranspiration, by species.
4. Adaptability field trials are necessary which will be properly designed to evaluate long term performance of the most promising species which exist in Alberta.
5. Root and top pruning of reclamation deciduous stock requires further study to determine to what extent, how and when, pruning will be most beneficial.
6. The utilization of cuttings in reclamation programs shows promise. Guidelines are necessary for the users of cuttings as to time of cutting, type of cutting, methods of removal and storage, size of cuttings by species, and proper handling and planting techniques.
7. Deciduous reclamation stock requires larger containers than coniferous stock due to the greater root development. Studies are necessary to determine the optimum container for individual reclamation species being utilized.

With respect to species selection:

1. Alberta should concentrate on selection of desirable genotypes (ecotypes) from within the natural variability of native species.
2. A limited breeding program should be carried out where desired genetic characteristics do not exist in the native populations.
3. A full scale breeding program should be considered in the future, but not for at least ten years.

4. Native species in the Province should be screened and rated for potential.
5. Suggested criteria for selection are:
   a. availability of seed
   b. cold hardiness
   c. salt tolerance
   d. competitive ability
   e. drought hardiness
   f. low nutrient requirements
   g. provide a balance of rooting habit
   h. ability to fix nitrogen
   i. provide adequate ground cover quickly
6. Selected genetically based characteristics should be considered in terms of their value in general reclamation as compared to site specific reclamation. Research priorities should be assigned accordingly.
7. Survival, growth and vigor are considered to be characteristics of highest priority.
8. Seed production and related seed physiology work is of only slightly lower priority to those listed in (7).
9. Site specific traits (palatability, aesthetics, ability to withstand pollution) are presently of secondary priority.
10. Research into vegetative propagation of genetic material is probably of greatest importance for site specific problems.
11. Autecological studies (ecophysiology and genecology) are considered to be extremely important.
12. Phenological studies are considered to be of high priority in the context of (11).
13. Species trials (progeny tests) of selected genotypes should be carried out and should include detailed observations of variables from the site of collection and their relationship to variables on the disturbed test sites.
14. Microclimatic studies are considered to be of high priority in the context of (13).
15. Seed orchards or seed production areas consisting of selected genotypes or clones of genotypes should be established.
16. External treatments to enhance seed production in seed orchards or seed production areas should be investigated.

17. A research program on the genetics of native species for reclamation should not be carried out to the exclusion of exotic species. The latter 'have much to offer in both short-term and long-term application.
18. Solicited and unsolicited proposals for research into the genetics of native species should be backed by adequate literature reviews.
19. The Government of the Province of Alberta should make the commitment to initiate and support a long-term program of genetic research on the use of native species for reclamation and other purposes.

LIST OF OSRIN REPORTS

OSRIN reports are available on the University of Alberta's Education & Research Archive at http://hdl.handle.net/10402/era.17209. The Technical Report (TR) series documents results of OSRIN funded projects. The Staff Reports (SR) series represent work done by OSRIN staff.

OSRIN Technical Reports – http://hdl.handle.net/10402/era.17507

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BGC Engineering Inc., 2010. Review of Reclamation Options for Oil Sands Tailings Substrates. OSRIN Report No. TR-2. 59 pp. http://hdl.handle.net/10402/era.17547

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Jones, R.K. and D. Forrest, 2010. Oil Sands Mining Reclamation Challenge Dialogue – Report and Appendices. OSRIN Report No. TR-4. 258 pp. http://hdl.handle.net/10402/era.19092

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