

DEPARTMENT OF RENEWABLE RESOURCES
UNIVERSITY OF ALBERTA
Renewable Resources 368/768

REN R 768: Available only to students in MAg, MBA/MAg, MF, or MBA/MF, or by consent of Department.

Course name: RENR 368/768 Management and Utilization of Forest Genetic Resources

2018 Syllabus

Instructor	Dr. Barb Thomas (BT) Associate Professor NSERC/Forest Industrial Research Chair in Tree Improvement Office: 4-34 Earth Sciences Building Telephone: 780-492-8016 Email Address: bthomas@ualberta.ca Office Hours: by appointment		
Term	Winter 2018		
Classes	M, W, F	10:00 to 10:50 h	<u>T 1-90</u> (Tory Building – east of ESB)
Labs	F	14:00 to 17:00 h	BioScience Greenhouse CW-643 (1x/month, 2 field trips)
Credits	3 credits		

Policy about course outlines can be found in Course Requirements, Evaluation Procedures and Grading of the University Calendar.

Course Description

Basic principles in plant genetics and resource utilization including tree improvement and reclamation will be covered and placed in the context of current government policy. Regular lectures will be supplemented with guest lectures and one lab exercise or field trip per month, an individual term report (768) or group report (368) combined with either a poster or oral presentation will be assigned. Students taking 768 will also be required to present a paper of their choice and lead a discussion in the class. There is no additional cost for the field trips.

Prerequisite: *30 university credits.

Course Pre-Requisites (REN R 368)

*30 university credits.

Students are responsible for ensuring they have the necessary pre-requisites. Students will not receive credit for this course if prerequisites are not met, even if they complete the course. If the instructor agrees to waive a prerequisite, students must fill out a form in the office of Student Services and get a signature from the instructor.

Course Format

Lectures will be held three times a week covering basic concepts in understanding a plant phenotype, selection, heritability and breeding concepts. Guest lectures will supplement the regular lectures presenting work on government tree improvement programs, seed physiology, shrub utilization in the province and linking traditional forest genetics and genomics. Groups or individuals will make presentations during class time. There will be two lab sessions held on campus where hands-on breeding will be conducted and studied using trembling aspen. In addition, there will be two field trips, one to the University of Alberta Botanical Gardens (near Devon) and the second one to the Alberta Tree Improvement and Seed Centre and an adjoining commercial nursery near Smoky Lake (transport provided). Labs and field trips are mandatory.

Marking and Grading (RENR 368/768)

All assignments and worksheets are required to pass the course.

Access to Representative Evaluative Material

Samples questions will be provided on e-class prior to the mid-term and final exams. Learning outcomes are also provided under the 'Resources' section on e-class.

Weighting of marks for final grade determination

Exams, assignments and quizzes will be assigned marks on a percentage basis. These marks will be used to determine a **final mark (in percent)** according to the following weighting scheme:

RR368

Mid-term exam	25%
Final exam	30%
Participation	10%
Group term paper (including 5% for the literature review)	15%
Group term paper oral/poster presentation	10%
<u>Lab write-ups* (2.5% worksheets (2), 5% assignment (1))</u>	<u>10%</u>
Total	100%

*Labs 1&2 – worksheet #1; Field trip 2 – worksheet #2. Field trip 1 – assignment.

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All assignments and worksheets are required to pass the course.

Weighting of marks for final grade determination

Exams, assignments and quizzes will be assigned marks on a percentage basis. These marks will be used to determine a **final mark (in percent)** according to the following weighting scheme:

RR768

Mid-term exam	25%
Final exam	30%
Participation	5%
Individual term paper (including 5% for the literature review)	20%
Individual term paper oral presentation	10%
Individual lead paper presentation and discussion	5%
<u>Lab write-ups* (1% worksheets (2), 3% assignment (1))</u>	<u>5%</u>
Total	100%

*Labs 1&2 – worksheet #1; Field trip 2 – worksheet #2. Field trip 1 – assignment.

Student Learning Objectives, Outcomes and Competencies

Upon successful completion of this course students will be able to do the following:

- Describe basic plant genetic and evolutionary concepts
- Explain why genetics as an integral part of forest management
- Argue how and what role genetics can play in reclamation success
- Be able to articulate a basic understanding of the tree/shrub improvement (breeding) cycle
- Describe the context and application of forestry & reclamation in current government policy related to management of plant genetic resources in Alberta

Electronic Devices

Use of electronic devices during examinations is restricted.

- Only non-programmable calculators permitted;
- Cell phone calculators are not permitted during exams.

References and Readings

The following books are available from the UofA library or on-line. Consult the library online catalog for access.

1. Zobel & Talbert. Applied Forest Tree Improvement. 1984. Wiley. Pp 505.
University of Alberta Cameron – Science and Technology SD 399.5 Z83 1984
(reference desk)
2. White T.L., Adams W.T. & Neale D.B. 2007. Forest Genetics.
<http://www.cabi.org/cabebooks/ebook/20073206655>
<http://www.cabi.org/cabebooks/FullTextPDF/2007/20073206655.pdf>
3. Wright, J. Introduction to Forest Genetics. 1976. Elsevier Inc.
<http://www.sciencedirect.com/science/book/9780127652504>
4. Eriksson G., Ekberg I. & Clapham D. 2001. An introduction to Forest Genetics.
<http://www.slu.se/Forest-Genetics-online>
5. Chai, S-L., B. Eaton, J. Woosaree, D. Rweyongeza and E. Fraser. 2013. Seed Transfer of Woody Shrubs in Alberta – Are Current Seed Zones Applicable? Prepared by Alberta Innovates - Technology Futures, Vegreville, Alberta and Alberta Environment and Sustainable Resource Development, Edmonton, Alberta. 38 pp. (e-class)
6. Falconer & Mackay. Introduction to Quantitative Genetics. Fourth Edition. 1996.
Longman Group Limited. Pp464.
University of Alberta Cameron – Science and Technology QH 431 F18 2005
(Advanced)
7. Isik, F., Holland, J., and Maltecca, C. 2017. Genetic Data Analysis for Plant and Animal Breeding. Springer. (Advanced)

Google or use the link below to the Alberta Government web-site to obtain a copy of:

1. The Alberta Forest Genetic Resource Management and Conservation Standards – Volume 1: *Stream 1* and *Stream 2* (2016) (FGRMS) (also on e-class)

Note: this policy document guides the collection, production and use (deployment) of trees and shrubs in the province.

[http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/formain15749/\\$FILE/FGRMS_Stream1_2Dec2016.pdf](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/formain15749/$FILE/FGRMS_Stream1_2Dec2016.pdf)

E-Class Moodle

The course syllabus, limited lecture notes, information on projects, and additional resources will be placed on e-class. You should have a link to this class when you log on at:

<https://eclass.srv.ualberta.ca/portal/>.

Field trips (Mandatory):

There will be two field trips.

1. The first field trip will occur during the lab session time period with travel to the University Botanical Gardens. Well-maintained sample plots of hybrid poplar clones will be studied to understand phenotypic variation both within and between the poplar clones. The assignment is due for this field trip.
2. The second field trip occurs near the end of term and will be to the Alberta Tree Improvement and Seed Centre (ATISC) and Smoky Lake Forest Nursery (both located on the same site) where we will look at a commercial seed orchard, the government seed storage facility, the GoA seed testing and extraction lab and a commercial greenhouse growing trees and shrubs for both reforestation and reclamation. This field trip will occur on a Saturday and take all day. The second worksheet (#2) is due for this field trip.

Other Topic Important to the Course

Students enrolled in RR368 will be expected to work in groups (2-4) to develop a project for presentation to the class as either an oral presentation or a poster. Each group will be required to provide a 1-page outline for approval by the instructor prior to beginning their full project (check due dates & activities below).

Students enrolled in RR768 will be expected to work on their own to develop a project for presentation to the class **and** lead a discussion on a selected paper of relevance to their project. RR768 students will also be expected to participate in class and on all field trips.

Each group/individual can use the FGRMS policy document (noted above) to develop their project recognizing current government policy (eg: addressing requirements for the number of genotypes needed to meet unrestricted registration of seedlots for commercial deployment). A list of example topics are provided below.

Plagiarism and Cheating

General Student and Instructor responsibilities are outlined in **Sections 23 and 25** of the University Calendar: <http://www.registrar.ualberta.ca/calendar/Regulations-and-Information/index.html>. As Instructor, I am expected to clearly communicate class objectives, marking structure, expectations of students, give sufficient time to complete assignments, and mark exams and assignments in a timely fashion.

As students at the University of Alberta, you are subject to the Student Code of Behaviour (<http://www.governance.ualberta.ca/CodesofConductandResidenceCommunityStandards/CodeofStudentBehaviour.aspx>). Particularly relevant for this course (and all courses) is **Section 30.3.2: Inappropriate Academic Behaviour** (<http://www.governance.ualberta.ca/en/CodesofConductandResidenceCommunityStandards/CodeofStudentBehaviour/303OffencesUndertheCode/3032InappropriateAcademicBehav.aspx>), which outlines plagiarism, cheating, and academic misconduct. These academic offenses may result in sanctions against the offending student(s): (<http://www.governance.ualberta.ca/CodesofConductandResidenceCommunityStandards/CodeofStudentBehaviour/304SanctionsandTheirImpact/3042TypesofSanctions.aspx>.)

The University of Alberta is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Code of Student Behaviour (online at <http://www.governance.ualberta.ca/CodesofConductandResidenceCommunityStandards/CodeofStudentBehaviour.aspx>) and avoid any behavior which could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University.

Please note that copying previous student's or students' work from this class (or any other class) and handing it in as your own is considered plagiarism

Students should speak with the course instructor about any questions or concerns about the code. Students should be particularly aware of the code as it pertains to internet and library research.

Professionalism and Classroom Rules of Engagement

Students are expected to treat their instructor, guest speakers and fellow students with respect. That means coming to class on time and not leaving before the class has been formally dismissed, and not participating in disruptive behaviour in class. The use of iPods, mp3 players, cell phones, or blackberries during class is prohibited. Laptops or tablets may be used if they are for taking notes, not for checking Facebook!

Students are encouraged to attend all classes although marks are not being assigned for attendance. **Class discussions may result in questions on the final exam and there are marks for participation.**

Students doing collaborative projects are expected to divide up the work-load and **all members of the group are expected to participate in the class presentation.**

If an absence occurs from the day a group presents or from the mid-term, field trips or final exam, a medical letter will be required to either defer the exam or weight the final exam more heavily.

NOTE: Late assignments will be assessed a 5% deduction per day.

Final Grades

Students will be assigned a final letter grade based on their final mark. University policy for grades and student evaluations are outlined on the following website:

<https://policiesonline.ualberta.ca/PoliciesProcedures/Pages/DispPol.aspx?PID=101>

I will use the following as a guide to assign letter grades for undergraduate students:

Descriptor	Letter Grad	Grade Point Value	Final Mark (percent)
Excellent	A+, A, A-	4.0, 4.0, 3.7	90-100
Good	B+, B, B-	3.3, 3.0, 2.7	75-89
Satisfactory	C+, C, C-	2.3, 2.0, 1.7	66-74
Poor	D+	1.3	56-65
Minimal Pass	D	1.0	51-55
Failure	F, F4*	0	50 or less

*F4 denotes eligibility of student to apply for reexamination of a course

I will use the following as a guide to assign letter grades for graduate students:

Descriptor	Letter Grad	Grade Point Value	Final Mark (percent)
Excellent	A+, A, A-	4.0, 4.0, 3.7	90-100
Good	B+, B	3.3, 3.0	76-89
Satisfactory	B-, C+	2.7, 2.3	66-75
Failure	C, C-, D+, D F	2.0, 1.7, 1.3, 1.0, 0	65 or less

NOTE: Students in RR768 must achieve a C+ to pass.

Recording of RR368/768

“Audio or video recording, digital or otherwise, of lectures, labs, seminars or any other teaching environment by students is allowed only with the prior written consent of the instructor or as a part of an approved accommodation plan. Student or instructor content, digital or otherwise, created and/or used within the context of the course is to be used solely for personal study, and is not to be used or distributed for any other purpose without prior written consent from the content author(s).”

Due Dates & Activities

All worksheets and assignments are due on time. If the project report or final lab report are late, a penalty of 5% per day (including weekends) will be taken off the mark.

The following are important dates.

Wed	January 24 th	1-page outline of project due by 4pm (email to instructor)
Friday	January 26 th	First lab (aspen breeding)
Friday	February 9 th	Second lab (aspen breeding), aspen breeding worksheet #1 due at end of lab-2.5% (includes both greenhouse labs)
Friday	February 16 th	Mid-term (during class-time)
Friday	March 16th	<i><u>Field trip to the UofA Botanical Gardens (2-5pm)</u></i>
Friday	March 23 rd	Botanical Garden assignment due (5.0%)
Monday	March 26 th	All TERM projects handed in by 10:00am (electronic & hard-copy (in-class))
Mon. & Wed. & Wed. March 26 th & 28 th April 4 th		Group (RR368) or individual (RR768) presentations
Saturday	April 7th	<i><u>Field trip to Smoky Lake (8-5pm)</u></i>
Wed.	April 11 th	Final Smoky Lake trip lab worksheet #2 due by 4pm (hard-copy: 2.5%)
Fri.	April 13	Last day of class
Wed.	April 25 th	Final exam, 9:00-11:30am

Tentative Schedule

The class will be divided into two sections:

<u>Month</u>	<u>Lecture Topic</u>
January/Feb	Genetic theory
February/March	Tree/plant improvement and links to silviculture and forest policy

Link to travel permission form – please provide before the first field trip:

https://policiesonline.ualberta.ca/policiesprocedures/infodocs/@finance/documents/forms/cmp_062134.pdf

Term Project:

Primary objective:

1. Develop a plan for a tree or shrub improvement program:
 - Define the objective of your program
 - Select a species and region (for collection and deployment of material)
 - Select traits of interest to 'improve'
 - Eg: volume, wood density, drought resistance, insect resistance, rooting, salt tolerance etc.
2. Review supporting documentation and references in suggested texts and web-sites below:
 - Zobel & Talbert. Applied Forest Tree Improvement. 1984. Wiley. Pp 505. University of Alberta Cameron – Science and Technology SD 399.5 Z83 1984 - reference desk
 - White T.L., Adams W.T. & Neale D.B. 2007. Forest Genetics.
<http://www.cabi.org/cabebooks/ebook/20073206655>
<http://www.cabi.org/cabebooks/FullTextPDF/2007/20073206655.pdf>
 - <http://www.abtreegene.com/reports.html>; <http://www.abtreegene.com/toolkit/>
 - The Alberta Forest Genetic Resource Management and Conservation Standards – Volume 1: *Stream 1* and *Stream 2* (2016) (FGRMS)
Note: this policy document guides the collection, production and use (deployment) of trees and shrubs in the province of Alberta.
[http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/formain15749/\\$FILE/FGRMS_Stream1_2Dec2016.pdf](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/formain15749/$FILE/FGRMS_Stream1_2Dec2016.pdf) Check e-class for PDF.
3. For all references including books and manuscripts or journal articles, cite in the text and provide the full citation in a literature section of your report following the manuscript preparation rules for the Canadian Journal of Forest Research. Google, instructions to authors for this journal to find the rules and also look at a few papers from this journal to understand how to cite correctly in the text. Provide proper figure and table legends.
4. Develop the basic plan with corresponding time-lines including:
 - Plan the selection of parent material including strategy, numbers required, what type of material is collected (eg: scion, seed, cores)
 - Describe how you will collect and where the parent material will come from based on the strategy
 - Develop 'orchard' or stoolbeds for production (based on amount of seed or cuttings you desire in your program)
 - Consider the deployment objectives from the program (eg: 400 ha annually with 1800 trees planted per ha)
 - Design the field testing that will go along to support the operational seed/cuttings production for ultimate deployment or reclamation. The field testing program should address adaptation issues and be designed to meet the program objectives and cover the deployment region.

Examples of topics:

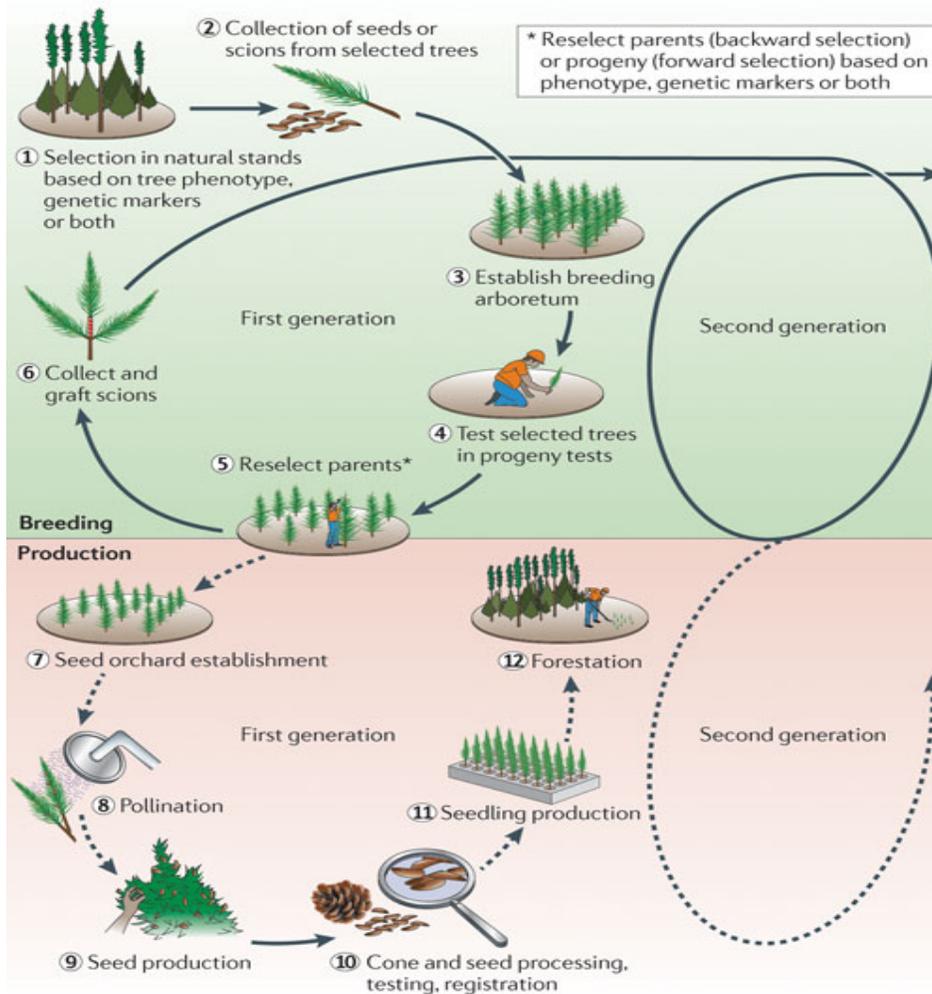
1. Develop a shrub program for blueberries in the Fort McMurray oil sands region
 - a. Consider if you will use seeds or cuttings, if you want a shrub orchard? How many plants (genotypes) do you need for this? How many seeds do you want from the orchard? How much area annually do you want to reclaim?
 - b. Determine where the parent material will be collected from to develop your orchard.

2. Develop a tree improvement program for drought tolerant Lodgepole pine for the Grande Prairie region of Alberta
 - a. Define the area
 - b. Determine the number of parents needed and how many test sites will be needed for adaptation testing
 - c. Determine where you will put a seed orchard and if it will be clonal or a seedling orchard
 - d. Determine the time-lines on testing and production of seed for reforestation and deployment

3. Develop a better variety of Christmas Tree
 - a. Determine the species
 - b. Determine the traits of interest (eg: needle retention, colour, shape etc.)

1-pager: Provide the title of your program, the species and selected trait(s) for improvement, the region you are targeting for deployment and if it is a breeding program, a clonal program or both. (Include names for each team as well.)

Example of a Tree Improvement Cycle:



Nature Reviews | Genetics

REMEMBER: Relentless Incremental Improvement = RESULTS

Section one: Genetic theory

Week 1

- January 8 Review of course Syllabus, outline, overview of TI and handout to fill in.
- January 10 1. INTRODUCTION: https://www.youtube.com/watch?v=6WR_d3KSWK0
Radiata pine breeding 3:19 min
https://www.youtube.com/watch?v=Ew8O_o3wDt0, Embryogenesis of radiata pine:
tree obstetrics on a commercial scale, 5:45 min
<https://www.youtube.com/watch?v=w8hygpNsVOI> , Forest Genetics Council of
British Columbia – Protecting Forest Health for Future Generations. 2:47 min.
Definition of plant breeding; History of plant breeding; Domestication; Forest
breeding; Objectives of forest breeding. Overview of a breeding program.
Term Paper discussion.
- January 12 2. INTRODUCTION CONTINUED

Week 2

- January 15 3. MOLECULAR GENETICS: DNA; RNA; Nucleotides; Amino acids; Proteins
- January 17 4. CYTOGENETICS: Chromosomes; Meiosis; Mitosis.
- January 19 5. CYTOGENETICS CONTINUED

Week 3

- January 22 6. QUALITATIVE INHERITANCE: Mendelian genetics; Mendelian laws; Genetic
linkage and recombination; Dominance; Epistasis
- January 24 7. POPULATION GENETICS I: Hardy-Weinberg Equilibrium; Inbreeding and
Heterosis
- January 26 8. Part I continued.... (+ discussion of what to look for in the lab)
- January 26th *First aspen lab BioSci Greenhouse (pollen extraction) Meet at Second Cup –
East entrance to Botany Wing of BioSci Building*

Week 4

- January 29 9. POPULATION GENETICS II: Evolutionary Forces: Genetic Drift, Mutation,
Migration and Selection.
- January 31 10. Part II continued....
- February 2 11. QUANTITATIVE GENETICS I: Quantitative Traits: Polygenes and Pleiotropy.

Week 5

- February 5 12. QUANTITATIVE GENETICS II: Genetic Variability; Heritability; Selection and Genetic Gain (breeding values).
- February 7 13. QUANTITATIVE GENETICS III: Genetic correlation; Environment; Phenotypic plasticity; GxE.
- February 9 14. Quantitative genetics continued....
- February 9th Second aspen lab BioSci Greenhouse (pollination) Worksheet #1 due.

Week 6

- February 12 15. SELECTION & EVOLUTION: Micro & Macroeolution; Natural & Artificial Selection; Selection Pressure; Response to Selection; Selection Differential.
- February 14 16. Selection and Evolution continued.....
- February 16 **Mid-term exam – during class time.**

Week 7

- February 19 **Spring Break**
- February 21 **Spring Break**
- February 23 **Spring Break**

Section two: Tree Improvement/Policy

Week 8

- February 26 17. Provenance variation: local adaptation, a study case – **Dr. Stefan Schreiber**, Boreal Research Institute, NAIT
- February 28 **RR768 student lead discussions (15-20 min each)**
- March 2 **RR768 student lead discussions (15-20 min each)**

Week 9

- March 5 20. Alberta Tree Improvement Programs, policy and seed use directive – **Andy Benowicz**, Geneticist AAF
- March 7 21. Economics of tree improvement - **Shuo Wang**, MSc student REES
- March 9 22. Forest breeding programs I (**BT**)

Week 10

- March 12 23. Forest breeding programs II, FGRMS (**BT**)
- March 14 24. Silviculture and genetics or data and collection – why is it important? (**BT**)
- March 16 25. Be prepared to discuss the following video:
<https://www.youtube.com/watch?v=VqjLL1BihWw> ~55 min, Awareness of genetics can enlighten silvicultural practices

March 16th Field trip to UofA BG (clonal poplar trial)

Week 11

- March 19 **Project presentations (RR368 student groups)**
- March 21 **Project presentations (RR368 student groups)**
- March 23 26. Policy to practice: applied forest gene conservation in Alberta- **Jodie Krakowski**, AAF

Week 12

- March 26 **Project presentations (RR768 individual students)**
- March 28 **Project presentations (RR768 individual students)**
- March 30 **Good Friday (Holiday)**

Week 13

- April 2 **Easter Monday (Holiday)**
- April 4 27. Seed handling & genetics with respect to FGRMS – **Lindsay Robb**, Seed Specialist AAF
- April 6 28. Reclamation using Shrubs – **Ann Smreciu**, Wildrose Consulting
- April 7th Saturday field trip to Smoky Lake ATISC (Managers ATISC, Lee Charleson; and Smoky Lake Forest Nursery, Larry LaFleur)*

Week 14

- April 9 31. Operational Tree Improvement - **Diane Renaud**, Hinton Wood Products, Westfraser.
- April 11 32. Tree Improvement model – RES-FOR project (**BT**)
- April 13 33. Last day of class – review.
- April 25 **9:00-11:30 am, Final (location TBD)**

Some videos:

<https://www.youtube.com/watch?v=w8hygpNsVOI>

2.47 min

Forest Genetics Council of British Columbia – Protecting Forest Health for Future Generations

<https://www.youtube.com/watch?v=gvKmroiaDCo>

3.0 min

Biodiversity on understanding forest genetic diversity (seed details etc.)

<https://www.youtube.com/watch?v=Tw-1O0U6eaA>

6:12 min

active gene conservation

https://www.youtube.com/watch?v=6WR_d3KSWK0

Radiata pine breeding

3:19 min

https://www.youtube.com/watch?v=Ew8O_o3wDt0

5:45 min

embryogenesis and radiata pine

<https://www.youtube.com/watch?v=VqjLL1BihWw>

~55 min

Awareness of genetics can enlighten silvicultural practices

<https://www.youtube.com/watch?v=gPWUbyohtDk>

Forest Genetic Resources Training Guide – Not only for geneticists

Fgr-training-guide@cgiar.org

<http://forest-genetic-resources-training-guide.biodiversityinternational.org/>

<http://forest-genetic-resources-training-guide.biodiversityinternational.org/>

Redwood Forests – Lumber Felling & Milling 1940's

10:26 min

https://www.youtube.com/watch?v=qb_YNZn_kaQ