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- Over the past 25 years; dramatic increase in concern for rare plants; both by stakeholders and government regulators
- Also in that time; understanding of rare plants and methodologies to assess impacts has improved greatly
- But some fundamental challenges remain; one of those is the topic today…

Our Topic Today

How can we accurately predict project impacts to rare plants if we do not know where all the rare plants are within the study area?

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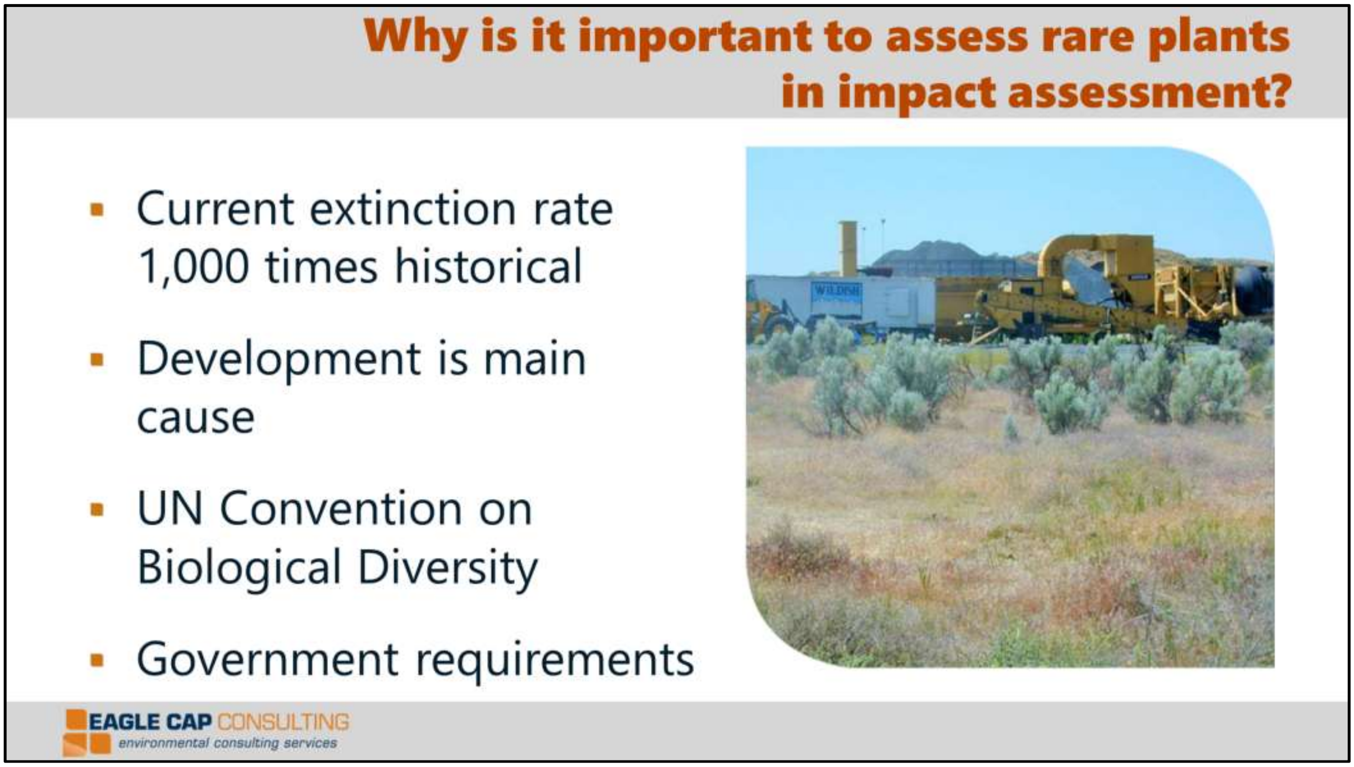
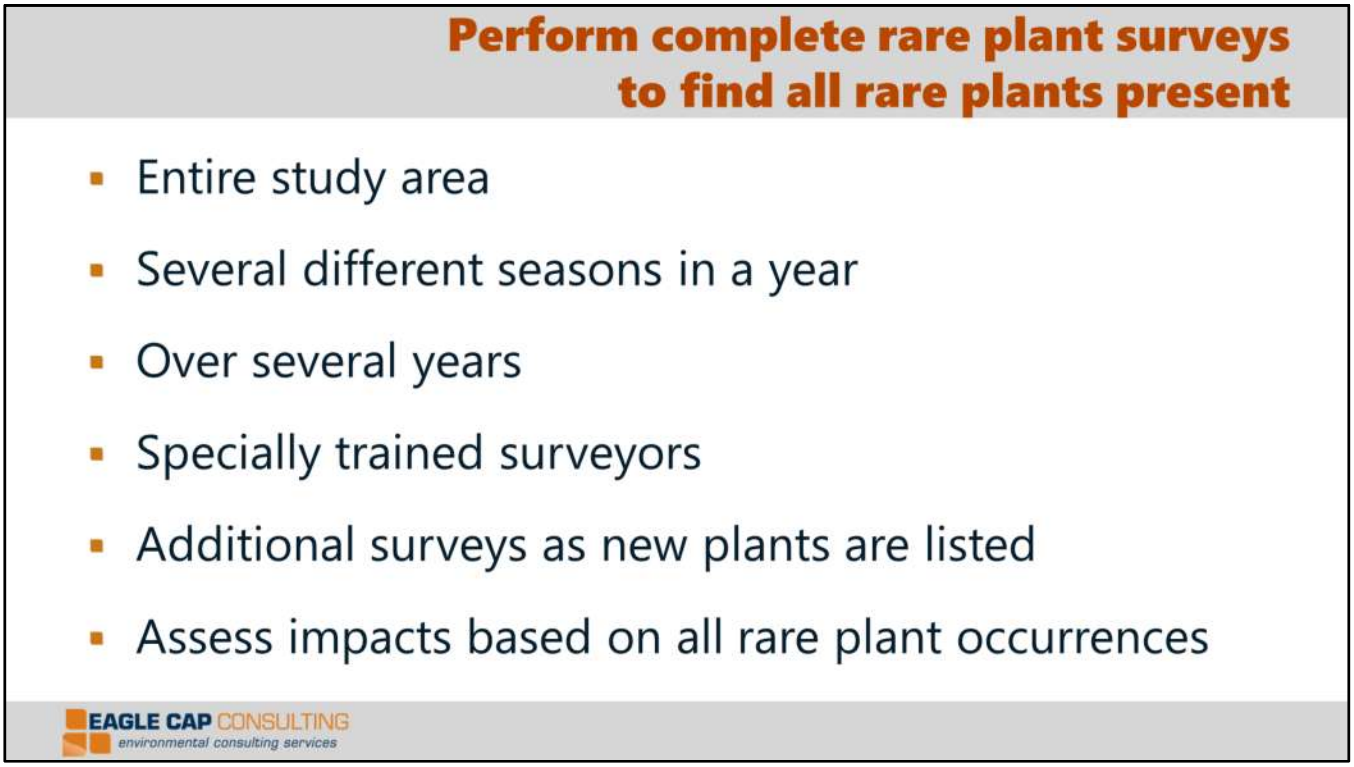


- 2014 international study on biodiversity (Pimm *et al.* 2014) concludes that current rates of extinction are ~1,000 times greater than historical background rate
- Same study: “The overarching driver of species extinction is human population growth and increasing per capita consumption.”
- Recent estimates are that perhaps 30% of all plant species are threatened (Pimm *et al.* 2014)
- Strong evidence that plant biodiversity is threatened on a number of levels
- Increasingly of concern to stakeholders
- In 1993 the UN Convention on Biological Diversity came into force; today 195 states and the EU are parties; demonstrates strong commitment to preserving biodiversity on global and national levels
- Government regulations and guidance require consideration of rare plant impacts
- Clear need to understand our impacts on rare species to preserve biodiversity

- How would an impact assessment address rare plants in a perfect world?



- Perform complete-level rare plant surveys and then assess impacts based on results; sounds simple but requires that:
    - Rare plant surveyors grid entire study area; transects ~100m apart depending on habitat
    - Two or more times per year, to cover all plant identification periods
    - Repeat over several years, to cover wet and dry years
    - Specially trained surveyors with specific rare plant experience in study region
    - Repeat surveys as new plants are listed
- If this level of survey was conducted; would know where all the rare plants were; could build a highly accurate picture of potential rare plant project impacts

- The reality is significantly different…

- Many project areas are too large to survey every piece of ground
  - Case study discussed later in this presentation; analysis area was 86,000 hectares or 860 km^2
    - *About 8.5 times the size of Florence, Italy*
- Access limited by physical and administrative factors, e.g. private lands

Time constraints limit the number of surveys that can be performed

- Short plant identification time windows
- Impact assessment is a time-constrained process

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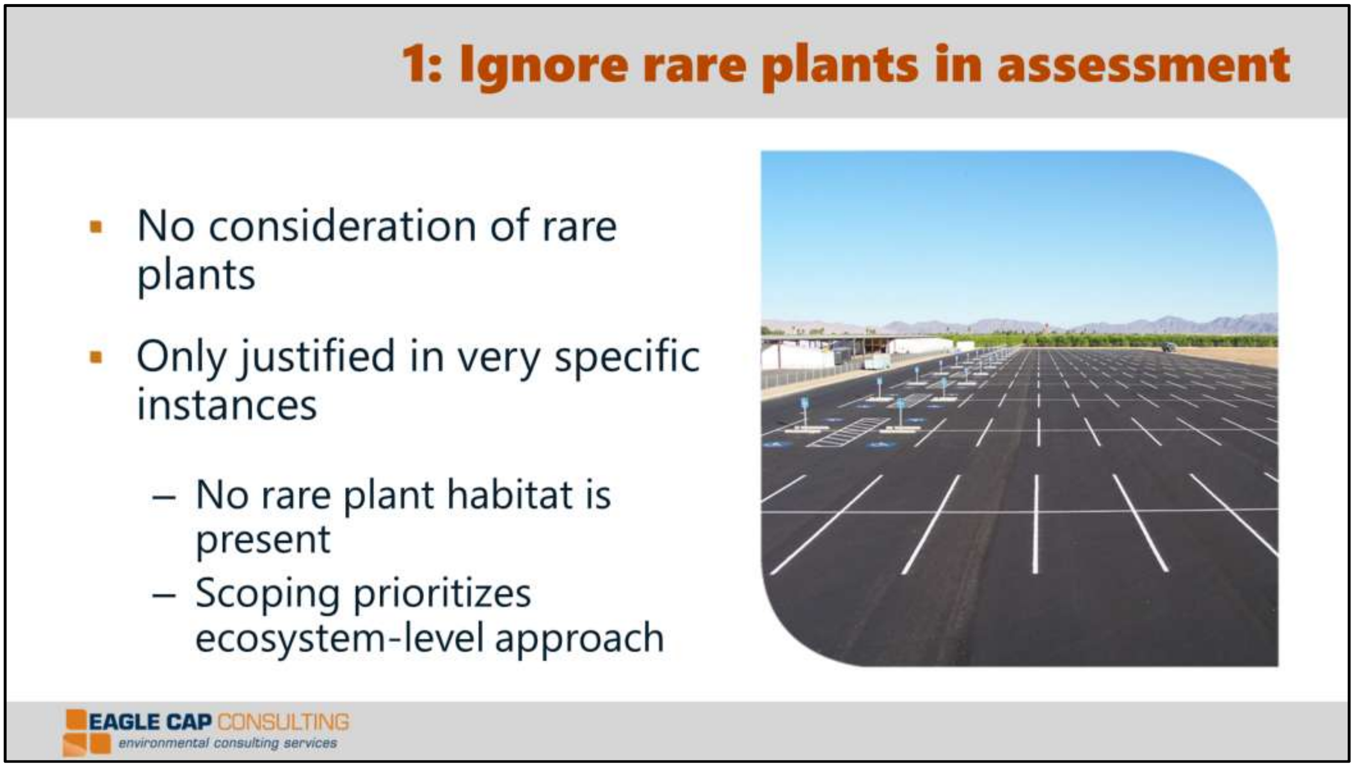
- Many rare plants only identifiable during certain seasons of the year
- Impact assessments must be completed on a certain limited schedule
  - US study (deWitt and deWitt 2008) examined over 2,000 federal Environmental Impact Statements; found average preparation time was 3.4 years; includes writing and review in addition to baseline studies
  - In many cases only 1 or 2 years available for field work

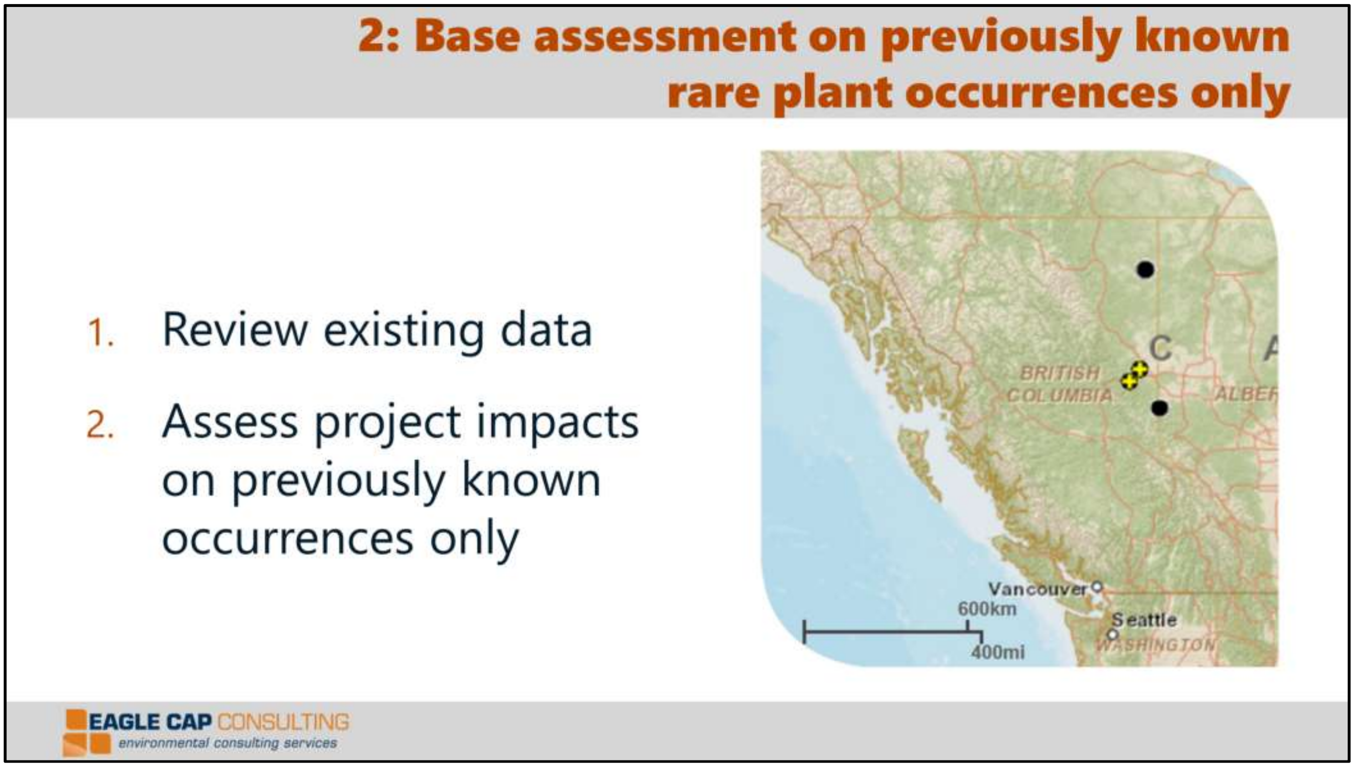
- Many other Valued Components to be considered
- Quick cost calculation for 86,000 ha case study analysis area:
    - Complete-level rare plant survey of the entire area; 2 passes annually for 3 years; field portion would cost at least CAD $103,200,000 or €77,300,000

- Rare plant surveyors must have highly specialized training
- Have experience with local flora and rare plant survey techniques
    - Saskatchewan guidelines (Saskatchewan Conservation Data Centre 2009) recommend minimum of 120 days taxonomic field experience for all surveyors (based on ANPC 2012); 10 years for team lead (based on Henderson 2009)
- Must be physically capable of traversing rough terrain in inclement weather
- Another quick calculation for 86,000 hectare case study analysis area:
    - If each surveyor covers 5 hectares per day; 573 botanists would be needed to complete one pass in a month-long plant identification window
- In 1999 Province of British Columbia, Canada estimated that less than 20 people in the province had the skills to perform a rare plant survey (BC Resources Inventory Committee 1999); undoubtedly more today, but not 573

- We reviewed a variety of recent impact assessment documents for major projects in Canada, US, Europe, and elsewhere
- Many varying approaches to addressing rare plants; however they can be grouped in four general categories



- Method 1: Ignore rare plants in the assessment
- May be justified in specific limited instances only:
    - *no rare plant habitat is present*
    - *pre-assessment scoping indicates ecosystem-based approach is preferable*
- These are edge cases only; vast majority of impact assessments should assess rare plants
- This approach is not common, but does still occur; majority of reviewed recent impact assessments did make some mention of rare plants



- Method 2: Assess on previously known occurrences only; the steps are:
    1. Prefield review of existing occurrence records; sources may include provincial Conservation Data Centres, herbarium records, and previous studies
    2. Use spatial analysis to predict project impacts to previously known occurrences only
- No rare plant field work is conducted; no analysis of impacts to suitable rare plant habitat
- May be justified in areas where extensive rare plant surveys have been previously conducted
- But in most cases, likely ignores large areas of unsurveyed suitable rare plant habitat
- Not common in the reviewed impact assessments but does still occur

3: Conduct rare plant surveys; assess impacts on known occurrences only

1. Review existing data
2. Perform rare plant surveys
3. Assess project impacts on known occurrences only

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- Method 3: Conduct rare plant surveys; then assess impacts based on occurrences that are found; this involves:
    1. Prefield review
    2. Rare plant surveys in portions of project area
    3. Spatial analysis to predict project impacts to known occurrences only
- No assessment of rare plant effects on unsurveyed or unoccupied habitat
- Ignores possible undiscovered rare plant occurrences in unsurveyed areas
- May understate magnitude and significance of rare plant impacts
- Common approach in reviewed impact assessments

4: Conduct surveys; determine likely habitat; assess on both

1. Review existing data
2. Perform rare plant surveys
3. Predict high-suitability rare plant habitats
4. Assess project impacts on known occurrences AND high-suitability habitat

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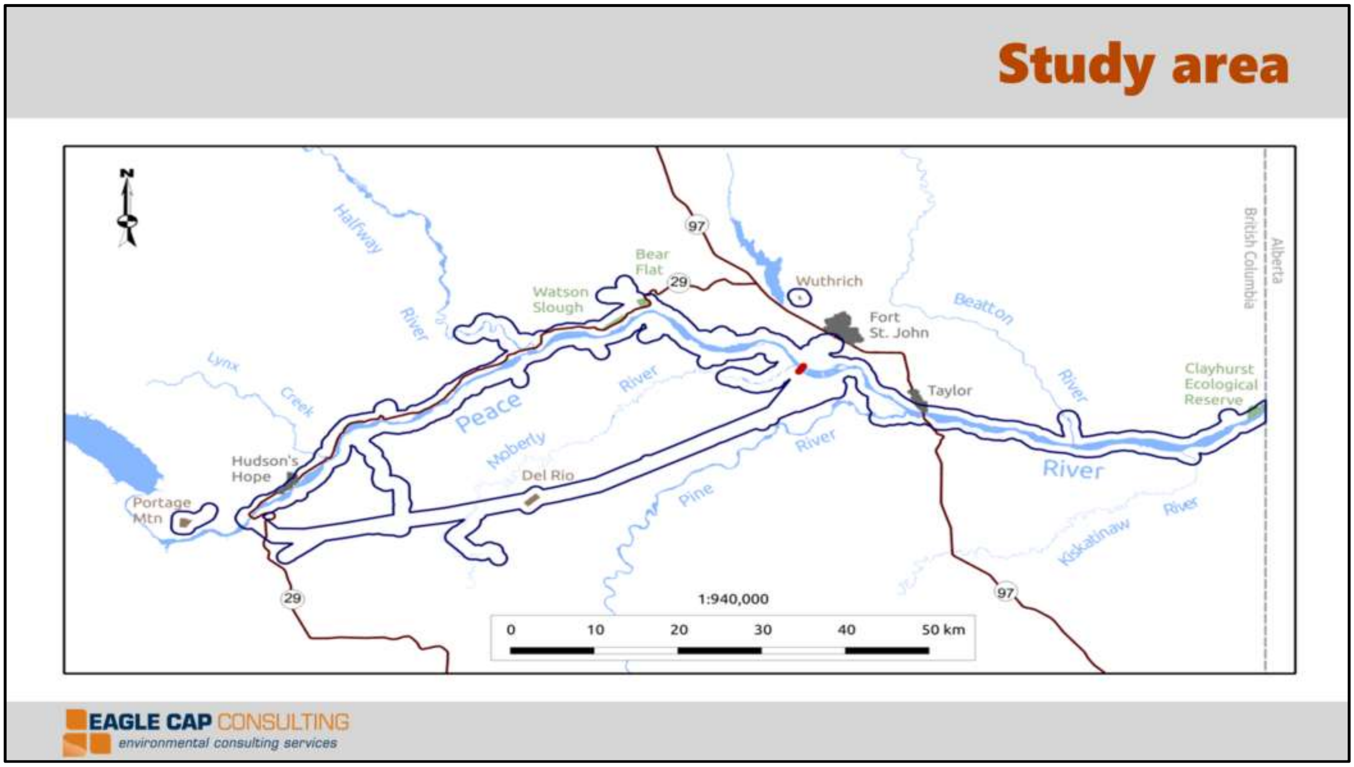
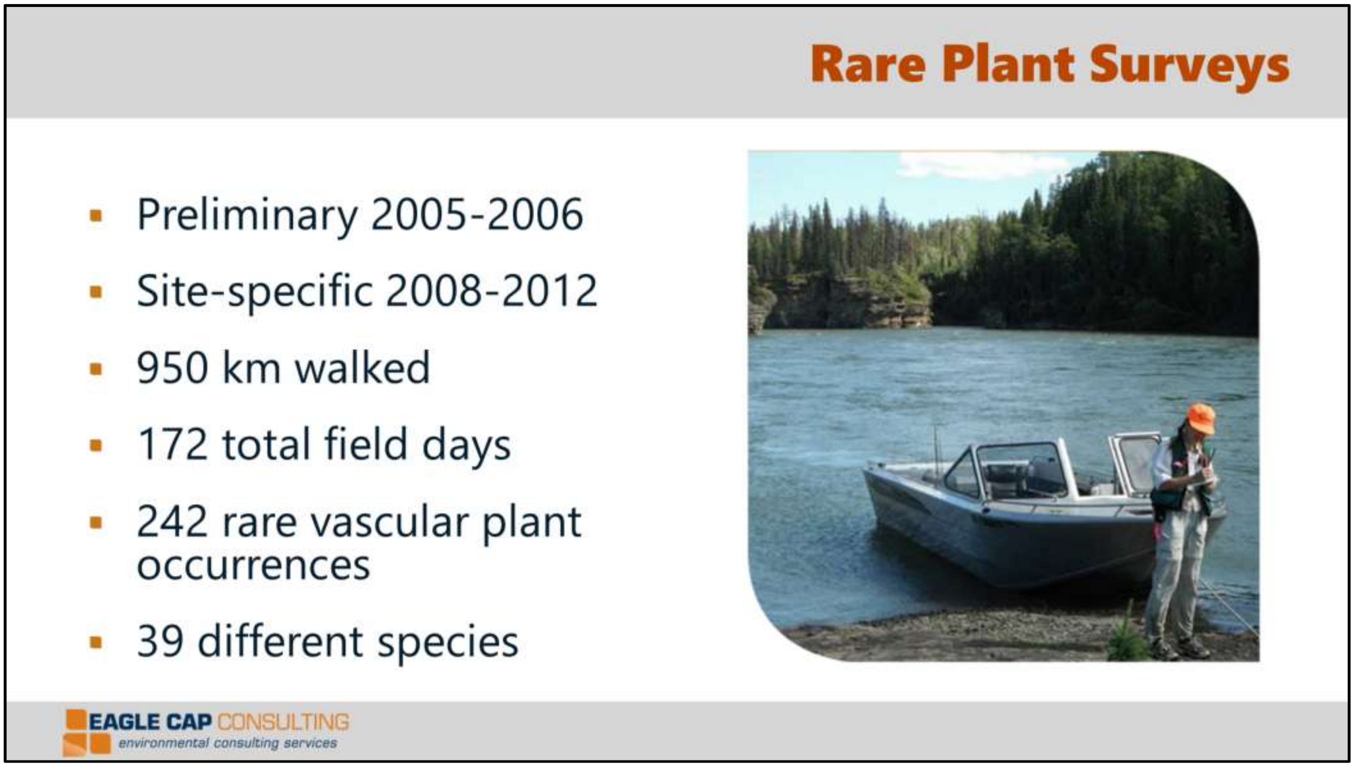
- Method 4: assess on both known occurrences AND high-suitability rare plant habitat
    1. Prefield review
    2. Rare plant surveys in portions of project area
    3. Some form of species distribution modelling to predict high-suitability rare plant habitats within study area
    4. Spatial analysis to predict impacts on known occurrences AND high-suitability habitat
- Approach incorporates (at least indirectly) possible undiscovered rare plants in unsurveyed areas
- Increases accuracy of impact assessment on rare plants
- Common approach in reviewed assessments from the province of Alberta, Canada; but not common elsewhere

- Case study: The Site C Clean Energy Project

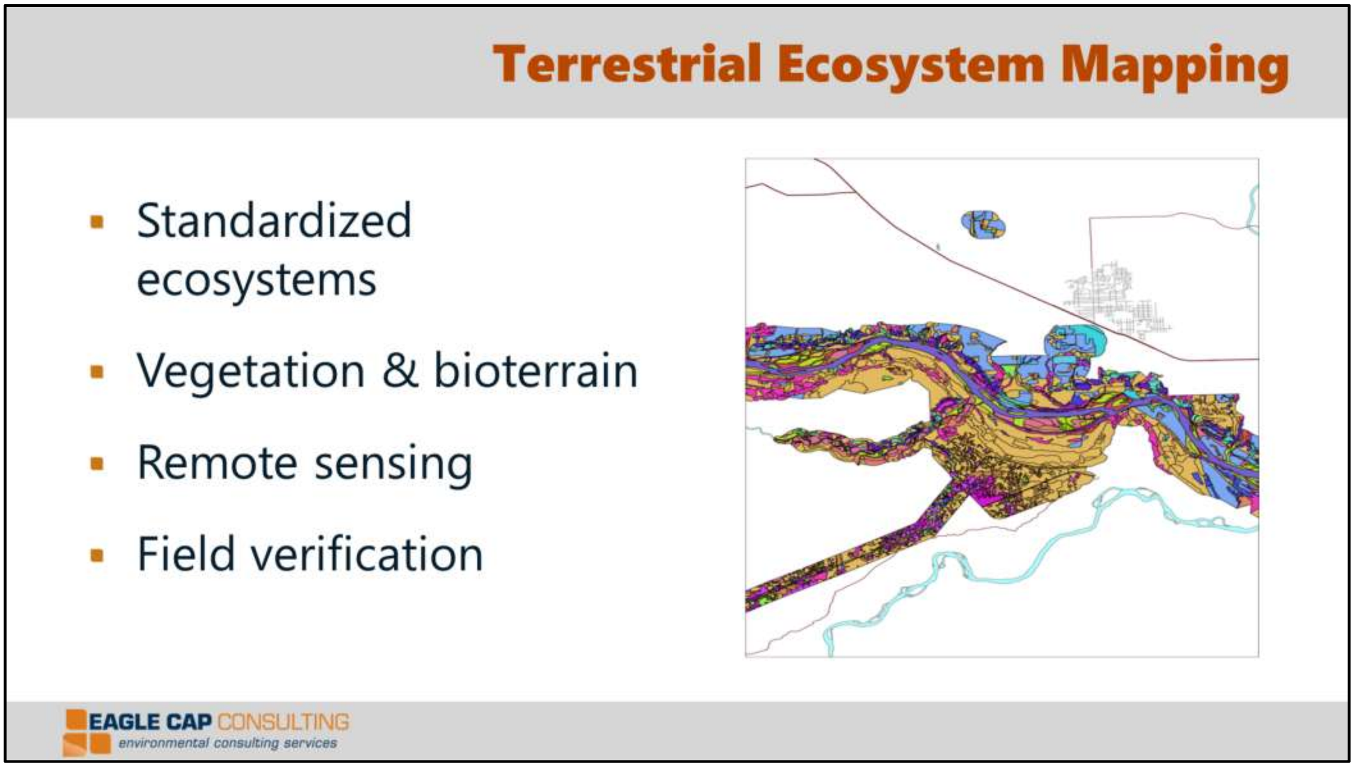
- Approved-but-not-yet-built 1,100 megawatt earthfill dam on the Peace River in Northeast British Columbia, Canada
- Dam will be over one kilometre long
- Reservoir 83 kilometres
- Dual 500kV transmission lines; 77 kilometres
- Ancillary facilities: borrow pits, substations, construction camps, etc.



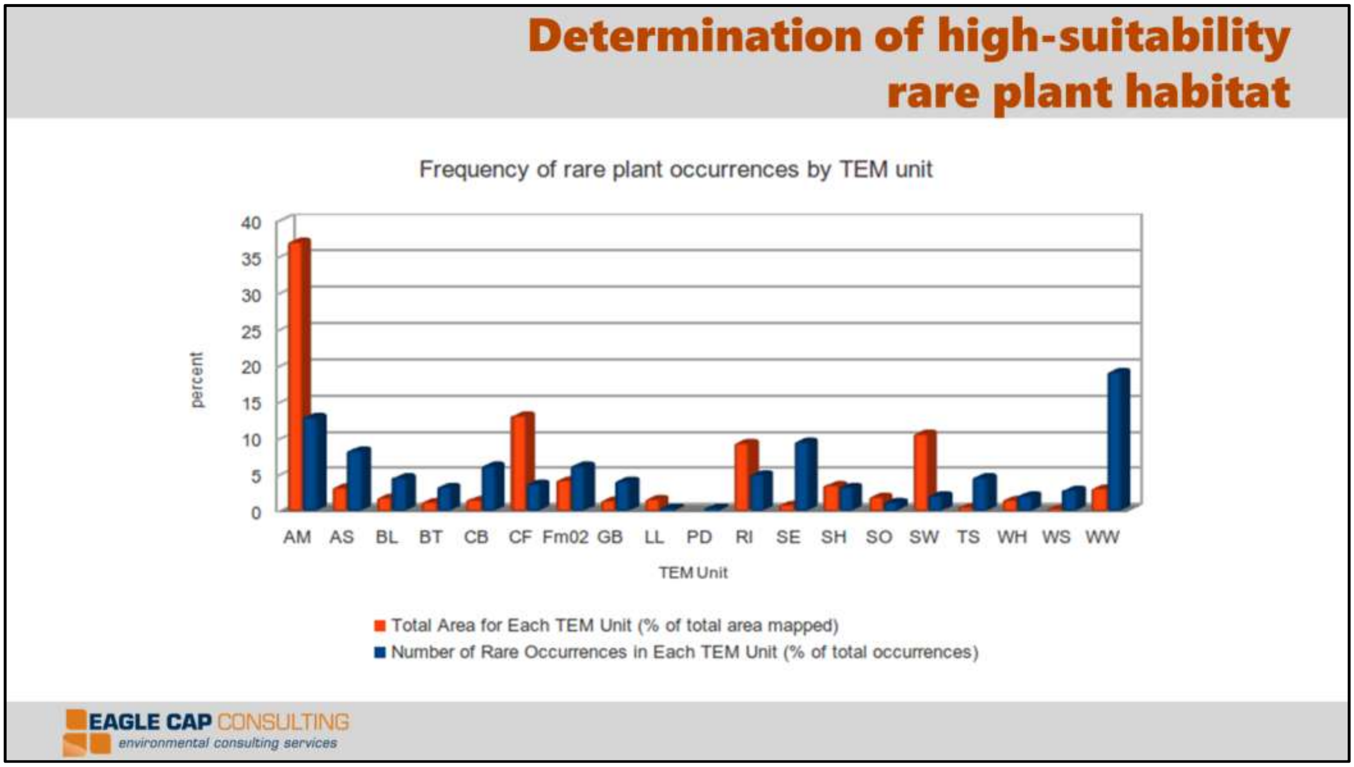
- Study area for vegetation Valued Component: 86,000 ha or 860 km^2
- Along Peace River for 145 kilometres; and follows transmission line route south of river



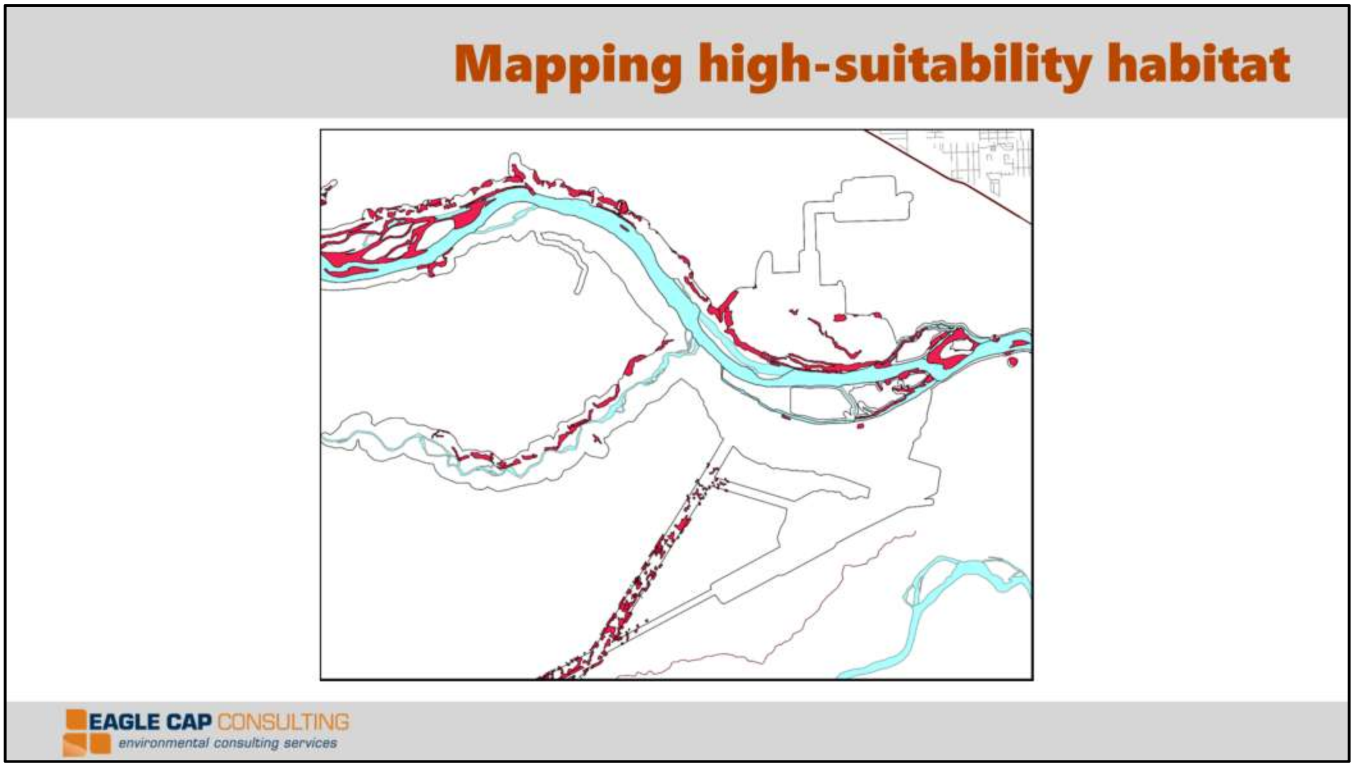
- Rare plant surveys were conducted
  - Preliminary general surveys in 2005 and 2006
  - Site-specific surveys in 2008, 2011, and 2012
  - ~950 km of survey transect walked by botanists
  - Total of 172 field days
  - 242 provincially listed rare vascular plant occurrences found
  - 39 different species.
  - Rare moss and lichen occurrences also found



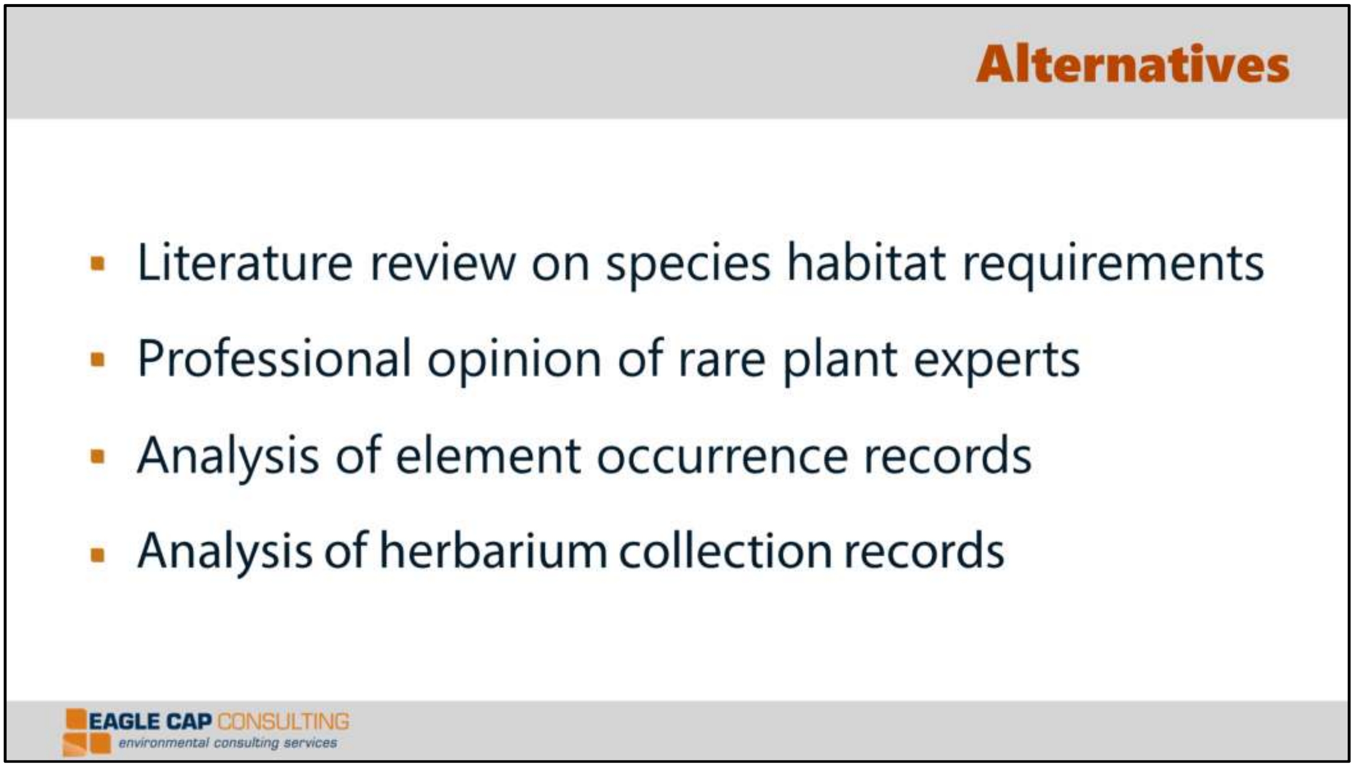
- Ecosystems were mapped
  - Used standardized Terrestrial Ecosystem Mapping procedures set out by Province of British Columbia
  - Divided area into polygons containing relatively homogenous vegetation and terrain features
  - Mapping based on remote sensing
  - Included extensive field verification
  - Produced spatial layer showing broad-level ecosystems



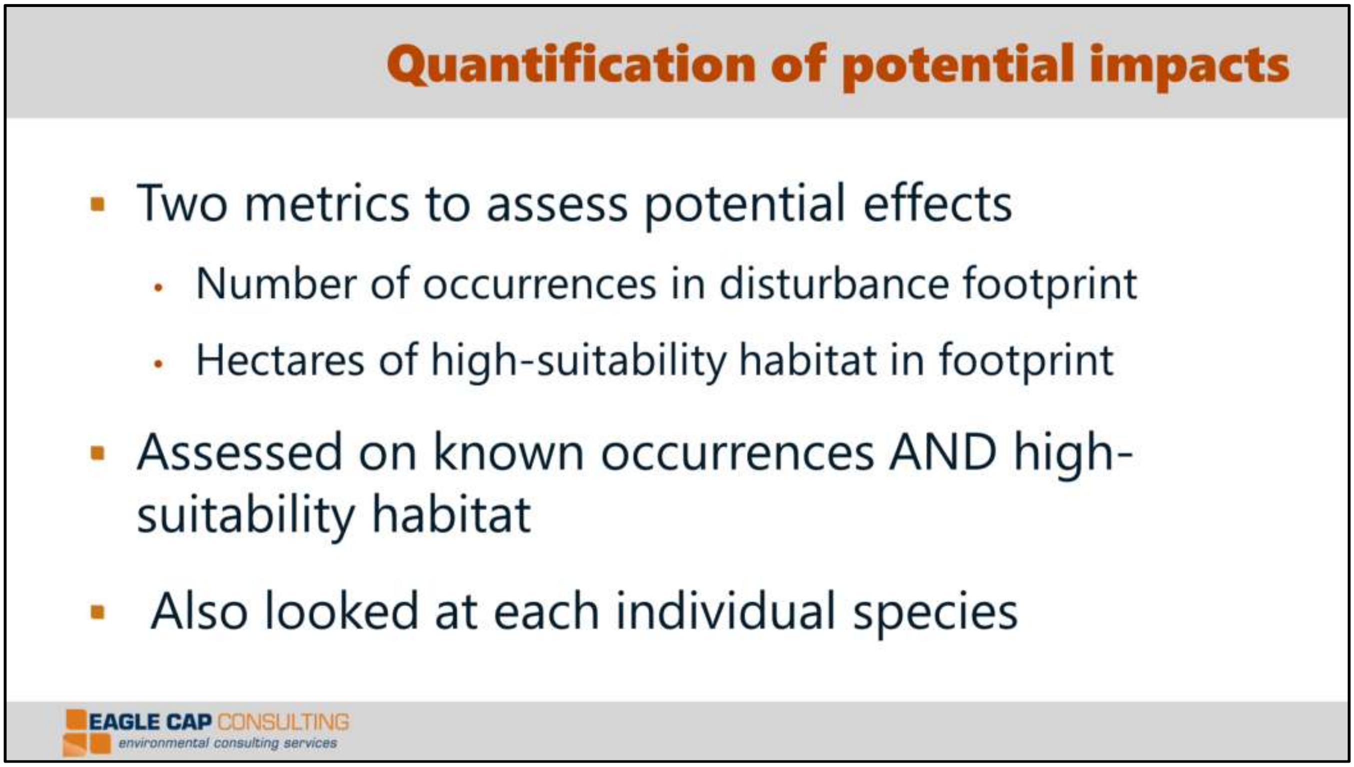
- Using spatially enabled database; ran queries to determine which ecosystem units had higher than expected numbers of rare plants
- Calculated areal cover of each ecosystem unit as percentage of total area mapped; orange bars on graph
- Calculated rare plant occurrences in each ecosystem unit as percentage of total occurrences recorded; blue bars
- If distribution of rare plants was random (not correlated with ecosystem unit), percentage of occurrences in each ecosystem unit should roughly equal percent coverage of that unit; this is not the case
- For example: first ecosystem unit on left (AM) covers ~37% of study area, but only contains ~12% of rare plants
- Conversely: ecosystem unit on far right (WW) covers ~3% of study area, but contains ~18% of rare plants
- Defined ecosystem units with more than 3 times expected rare plant occurrence frequency as "high-suitability" rare plant habitats
- See Hilton *et al.* (2013) for more details



- Then mapped high-suitability habitats



- Other methods could have been used; for example:
  - Literature review on species-by-species basis to determine rare plant habitat preferences
    - Performed for this project; however little information exists for many of the target species
  - Use professional judgement of rare plant experts to determine high-suitability habitats
    - Used for this project; again, little is known about many of the target species
  - Analyze element occurrence records; correlate with particular ecosystem units
    - Province of British Columbia has made some attempts to determine these correlations; but for rare species, data are scarce.
  - Analyze herbarium collection records; attempt to correlate with ecosystems
    - Collection records were reviewed for this project; but spatial information is often lacking, so difficult to extract quantifiable data
- Method used for Site C was chosen because project had large number of known occurrences, and reliable ecosystem maps



- Allowed for quantification of potential project effects to rare plants in two ways:
    - Calculate number of known rare plant occurrences overlapping project activity footprints
    - Calculate area of high-suitability rare plant habitat overlapping footprints
- Based assessment on known rare plant occurrences, and on high-suitability habitats
- Also quantified potential effects on each individual species (limited to known occurrences)

Limitations

- Does not capture unique features
- Uses all rare plants as a group
- Uncertainty in remote predictions
- Not suitable for occurrence-specific mitigation planning
- Species distribution modelling is not a substitute for on-the-ground surveys

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- Method has several limitations:
- Scale of ecosystem mapping does not capture all unique features
  - Rare plant occurrences often more associated with unique features such as outcrops, seeps, and soil inclusions, than with broader ecosystem types
- Used all vascular rare plants as a group, rather than each target species separately
  - There are widely varying habitat preferences between different rare plant species; grouping all rare plants may oversimplify impact predictions
- Always some uncertainty in remote predictions
  - Overall habitat suitability simply identifies areas with higher potential for occurrence of species group; no guarantee that particular plants occur there or do not
- Distribution modelling is not suitable for occurrence-specific mitigation planning
  - Occurrence-specific mitigations necessarily require knowledge of rare plant locations; additional pre-disturbance surveys are needed for mitigation
- Distribution modelling is not a substitute for on-the-ground surveys
  - Rare plant surveys are necessary in most areas to inform species distribution modelling; field surveys typically assess at a finer scale than distribution modelling can


CONCLUSION
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Rare plants are important to include in impact assessment

- Biodiversity is increasingly recognized as a valued environmental component
- Preservation of rare species is one key to preserving biodiversity

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- Biodiversity is increasingly recognized as a valued environmental component
- Preservation of rare species, including plants, is one key to preserving biodiversity

Surveys alone are not sufficient to assess impacts

- Fields surveys cannot confirm that all rare plants have been found.
- Accurate impact assessment requires that possible undiscovered rare plant occurrences be addressed.

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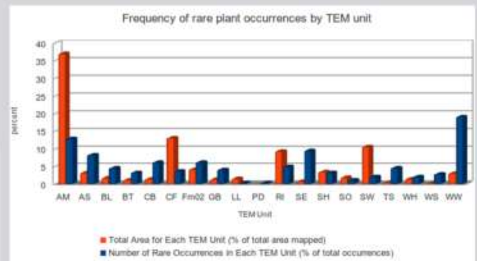
- Rare plant field surveys alone are not enough
- Even the most rigorous field survey cannot confirm that all rare plant occurrences within study are have been found
- Robust impact assessment requires that possible undiscovered rare plant occurrences be addressed

Field Surveys + Habitat Modelling = Robust Assessment

Rare Plant Survey

Habitat Modelling



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- Dual approach combining field surveys with distribution modelling incorporates unsurveyed suitable rare plant habitat into impact assessment process
- Then magnitude and significance of effects to the rare plant resource can be more accurately determined

- Questions or comments: contact Randy Krichbaum (rkrichbaum@eaglecap.ca)
- Bibliography on next page

References:

Note: Full bibliography can be found in Hilton et al. (2013)

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