Presentation Outline

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- BioImpact
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    - Species richness
Presentation Outline

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Life Cycle Assessment

“Internationally recognised scientific method of examining the total environmental burden associated with a product and its use. It embraces all the activities that go into making, transporting, using and disposing of that product.”

**Inputs:** raw material resources (petroleum, minerals, water, timber), energy in the form of fossil fuels and electricity, etc...

**Outputs:** Air and water emissions (CO$_2$, CO, nitrogen oxides, hydrocarbons, chemicals), solid wastes, etc...

**Impact categories:** Global warming, biotic resources, land use, human health, acidification, etc...
Why conduct a LCA?

• Improve environmental aspects of products at various stages in their life cycle

• Marketing (environmental image)

• Facilitate comparisons of environmental impacts of products with the same function; e.g. timber vs aluminium window frames

• Minimisation and improved utilisation of wastage

• LCA increasingly used as a decision-making tool
General scope of a LCA study

- resources use
- energy use
- emissions to air
- emissions to water
- emissions to soil
- further aspects

- extraction, mining, processing, manufacturing, transportation
- usable by-products
- main products
- residues/emissions
- distribution, use, maintenance
- biodeterioration and disposal
- usable by-products
- residues/emissions
LCA Models: Simapro
Biodiversity in forestry LCAs

- Two common assumptions:
  - Ignored, included as a caveat in the report to counter typical positive results in other areas
  - Use of proxies, leading to misleading or wrong comparisons

- Need for metric that fairly compares biodiversity impacts of production systems
Biodiversity

- Biodiversity or “biological diversity”
- Encompasses three levels
  - Communities and ecosystems
  - Populations and species
  - Genetic diversity
- Cannot measure it all!
- Surrogates often used
Biodiversity in LCIA

- Small number of attempts

- Generally northern hemisphere systems
  - Net primary productivity
  - Species richness
  - Threatened species approach
NPP Australia – Blue Mountains

- NSW Blue Mountains Wilderness Area
  - Majority classed “low productivity”
  - Flora - 152 families, 484 genera, ca 1500 species
  - 13% Worlds Eucalypts

www.visitbluemountains.com.au

flickr.com/photos/suburbanbloke/468339282
Species richness – inconsistent

Weinberg et al. 2008
Other biodiversity measures

- **Species diversity measures**
  - Alpha diversity
  - Beta diversity
  - Gamma diversity

- **Biodiversity toolkits**
  - Habitat hectares
  - Biometric
  - Biocondition
Conflict LCA and ecology - i

- Scale
  - LCA - Wood from Eden management region with integrated harvesting operations cf other operation
  - Ecology – Integrated harvesting within Timbillica dry sclerophyll forest (<50% of Eden region) in foothills (<500m elevation) cf unlogged sites in same area
Time

- LCA does not consider time to recovery and future biodiversity gains/losses

- Disturbance ecology is concerned with change over time
Time example

Study

a) Understorey

b) Large Shrubs
Re-inventing the wheel?

- Quantitative approach required
- Updatable
- Consider:
  - Process rather than site
  - Immediate impact of processes
  - Recovery from process
  - Product lifetime
- Nothing available
BioImpact method

- Series of questions with quantitative answers considering biodiversity cost and benefit
  
  - Large benefit
  - No effect
  - Large cost
  
  - Answers needed for each major taxonomic group
  - Based on published literature and expert opinion
BioImpact – key aims

To develop and refine BioImpact using four production systems in NSW:

- native forestry in the Eden region
- plantation softwood timber production in the Hume region
- and cropping and rangelands grazing in the Central-western region
BiolImpact – key aims

- To use a combination of literature reviews and direct expert input via surveys.
- To compare BiolImpact with species richness and NPP for the same production systems.
- To use results to refine BiolImpact.
Central West

- 70.3 M ha
- includes the Lachlan, Macquarie-Bogan and Castlereagh catchments
- rangeland grazing 3.4 M ha
- cropping 1.8 M ha
- forestry 0.013 M ha
Central West

- 0.2 M ha hectares of land held by farm businesses was set aside for conservation (ABS 2012)
- Tree cover across the upper Lachlan catchment is ~15% and about 1/3 of remnant tree cover occurs as scattered paddock trees (Fisher et al. 2010)
- 172 threatened species occur or did occur
- Most large remaining tracts of native vegetation are found in national parks, nature reserves or state forests and travelling stock routes, as well as areas with soils considered unsuitable for cultivation

Image
Eden

- 800 000 hectares
- ~2/3 of the region is forested. Most of this is public forest, either designated as state forest (25% of the total area) or national park (32%). Together, national parks and state forests total 452 000 hectares.
Case study areas

Eden

- About 3% of the State forest area or <1% of the total forested area is harvested each year for timber (Forests NSW 2005).
- <1% of the area of state forest is now old growth forest (though this would often exclude harvest exclusions on riparian zones). This low proportion has resulted from past extensive harvesting and transfer of significant portions into National Parks during the 1990s i.e. Eden Regional Forest Agreement.

Image © John Yurasek
Hume

- 89,000 ha of planted State forests
- PLUS 4,350 ha of joint venture plantation managed by the FCNSW on private land
- Privately owned plantation on freehold land across the south west slopes, mostly adjacent to or in close proximity to FCNSW plantings totals approximately 35,000 ha
Hume

- Retained areas of remnant vegetation exist within the state owned plantings.
- Remnants are predominantly in major drainage corridors or where biodiversity values have been identified.
- Since 1982 native forest has not been cleared during harvest or plantation establishment (Forests NSW 2008).
Literature based on biodiversity by taxonomic group per case study area
Developing the method

- Literature review - biodiversity by taxonomic group per area
- Initial Concepts survey – global
- identified Five Key Concepts

and from these

- developed 16 Key Questions
Two hundred and sixty-seven individual responses were received from 20 countries, dominated by Australia, the United States, New Zealand and Canada.
The majority of responses from academics then ecological consultants and student researchers.

Sixty-six respondents made comments. These were taken into consideration and assisted the formulation of a more refined list of questions.
Five Key Concepts

- Connectivity, fragmentation, isolation, gene flow

- Interactions
  - Invasive species
  - Natural disturbance regimes
Five Key Concepts

- Anthropogenic disturbance regime impacts
  - Frequency, duration, intensity, extent, recovery x frequency, succession

- Habitat structure, ecosystem function, resilience

- Threatened communities and species
The 16 Key Questions were workshopped with a group of ecologists at RMIT and subsequently refined.

Nineteen questions (Questions 1a through to 13d), were developed with three additional questions (A, B and C) to be answered using a GIS.
Literature Review

- 95 papers reviewed against
- 27 Central West (12 Cropping/pasture; 15 Rangeland grazing)
- 38 Eden Native forestry
- 30 Hume Plantation forestry
- Additional 96 papers yet to be reviewed
Each individual paper was considered against a question and subsequently given a score (if applicable), based on the response range associated with that question. The data relating to scores and references were then stored in a database.
From a total of 43 experts 24 responded to the survey.
Taxonomic expertise was relatively even per production system.
BiolImpact score

- Total biodiversity impact scores – literature and survey
Pine plantation in Hume has a higher biodiversity value than native forests contained in national parks in the same region, and also a higher biodiversity value than the Eden native forests managed for hardwood timber production.

<table>
<thead>
<tr>
<th>Region</th>
<th>Sub-region</th>
<th>GRASSY NPP Mean (SD)</th>
<th>Woody NPP Mean (SD)</th>
<th>Total NPP Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eden</td>
<td>Eden_total_area</td>
<td>0.536 (0.17)</td>
<td>1.739 (0.29)</td>
<td>2.275 (0.24)</td>
</tr>
<tr>
<td>Eden</td>
<td>Eden_State_Forests</td>
<td>0.464 (0.07)</td>
<td>1.929 (0.21)</td>
<td>2.393 (0.20)</td>
</tr>
<tr>
<td>Eden</td>
<td>Eden_National_Parks</td>
<td>0.502 (0.14)</td>
<td>1.800 (0.21)</td>
<td>2.302 (0.13)</td>
</tr>
<tr>
<td>Hume</td>
<td>Hume_total_area</td>
<td>0.911 (0.39)</td>
<td>1.061 (0.49)</td>
<td>1.973 (0.29)</td>
</tr>
<tr>
<td>Hume</td>
<td>Hume_Softwood</td>
<td>0.487 (0.21)</td>
<td>1.926 (0.41)</td>
<td>2.414 (0.24)</td>
</tr>
<tr>
<td>Hume</td>
<td>Hume_National_Parks</td>
<td>0.504 (0.24)</td>
<td>1.446 (0.43)</td>
<td>1.950 (0.32)</td>
</tr>
<tr>
<td>Central West</td>
<td>CMA excluding National Parks and State Forests</td>
<td>0.981 (0.51)</td>
<td>0.606 (0.37)</td>
<td>1.587 (0.60)</td>
</tr>
<tr>
<td>Central West</td>
<td>Average of National Parks in CMA</td>
<td>0.674 (0.33)</td>
<td>1.037 (0.45)</td>
<td>1.710 (0.44)</td>
</tr>
</tbody>
</table>
cropping and grazing systems have a higher biodiversity value than that of Eden and Hume managed forest systems.

Figure 12. Species richness per region: State forest/Softwood area per taxonomic group. Appendix 1 lists species within groups. ‘_rec’ indicates the number of records downloaded from the ALA for that taxonomic group.
Application in LCA

• BiolImpact can be implemented in an integrated fashion with LCI units as core part of a LCA database.

• It may be appropriate to combine the biodiversity scores with a measure of land occupation or land transformation

For the case studies selected here, the relevant elementary flows may be:

1) For cropping and pasture: Transformation, mixed cropping and pasture;
2) For hardwood: Occupation, Eden forest extensive;
3) For plantation softwood: Transformation, Hume forest intensive
Application in LCA

- Long-term production volumes, area required for production and area required for sustainable production

Land transformation and land occupation impacts due to native hardwood production in Eden and plantation softwood production in the Hume region.

<table>
<thead>
<tr>
<th>Production system</th>
<th>Elementary flow</th>
<th>Area harvested / year (ha)</th>
<th>Volume harvested / year (m³)</th>
<th>m²a (m²/m³.year⁻¹)</th>
<th>m²a / total harvestable area (m²/m³.year⁻¹/’000ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native hardwood; Eden</td>
<td>Occupation, Eden forest extensive</td>
<td>1260</td>
<td>220,000</td>
<td>57.5</td>
<td>0.64</td>
</tr>
<tr>
<td>Plantation softwood, Hume</td>
<td>Transformation, Hume forest intensive</td>
<td>3642</td>
<td>1,769,688</td>
<td>20.6</td>
<td>0.23</td>
</tr>
</tbody>
</table>

- Exploring numerical links between production intensity and biodiversity scores
Major points

- Final version of questions included in BioImpact answered based on biodiversity as a whole rather than taxonomic groups. However, consultation with broad base of experts specialising in different taxa is recommended.

“.....here is the common mistake of counting what is easy to count and then mistaking what is counted for what counts.”

Major points

- BiolImpact scores for the Eden region from both the literature review and expert survey were clearly lower than for other production processes, unlike the NPP and species richness methods.

- BiolImpact scores for the Hume region may have been lower if a clearer, more detailed description of the study area and process had been given to respondents.
Major points

- using NPP - a pine plantation in Hume would have higher biodiversity value than native forests contained in national parks in the same region, and also a higher biodiversity value than the Eden native forests managed for hardwood timber production.

- using species richness - CW systems would have a lower biodiversity impact score than that of Eden and Hume managed forest systems.
Advantages of BiolImpact

- Discerns impacts from different land use
- Does not focus on individual taxa – it encapsulates different components of biodiversity
- Access to literature and experts means it can be applied in any country
- Places emphasis on changes in species composition (including the concept of evenness) rather than change in species richness alone
Key Benefits of BioImpact

- The key benefit to the forest industry from this project is the demonstration of the applicability of a method that comprehensively and holistically assesses the biodiversity impacts of forestry operations.

- The default assumption in LCAs involving forest products is that the perceived biodiversity impacts from forestry operations negate other positive environmental outcomes (e.g. low greenhouse footprint, carbon sequestration). Through application of BioImpact this assumption can be explicitly tested.
5 Steps for BioImpact application

1. Carry out initial literature survey for region and production system in question (including “grey” literature)

2. If gaps are identified in 1, carry out a secondary literature survey for any literature available for areas with similar production systems and species composition, to be used as a proxy.

3. Expert consultation either remotely (e-mail, discussions via Skype) or via a workshop with selected experts. The specific structure of this step is ultimately the discretion of the person applying BioImpact. As a guide, we suggest that the consultation process could adopt the following structure:
   - Consult experts with a range of taxonomic expertise
   - Presentation of the scenarios with clear descriptions of the regions in question and system boundaries, including any mitigation measures that the process follows to minimise impacts on biodiversity
   - Ask experts to give their scores for all questions
   - Present the scores derived from the literature review process and expert input to the experts, to allow experts to reflect on their original response in the context of other responses.
   - Carry out a final scoring round to achieve consensus, if the scatter in the data is high. This also allows experts to revisit their original scores and change them if they have misinterpreted any particular question

4. Use the literature review to obtain scores for the different questions, complemented by expert input where literature is non-existent

5. Determine a total biodiversity score by adding the individual scores for each question
Recommendations

- BiolImpact should be used to populate a database that would be freely available to LCA practitioners, beginning with the case studies considered in this report.
- Further support for a project to populate a database with a number of key production systems for AUS and NZ where biodiversity impacts are of concern. This would lower the average cost of study per production system.
- Application of BiolImpact for current LCA projects (e.g. NSW DPI agricultural LCAs)
- Investigate further the options and opportunities associated with the process of integrating BiolImpact in LCA systems
Next steps

- Carry-out some mathematical modelling to optimise derivation of final BioImpact scores
- Presentation at NZ LCA Conference
- Presentation in workshop: “Land Use in LCA: principles, methods and guidelines”
- Preparation of manuscript for IJLCA