SUSTAINABILITY BOUND?
A study of interdisciplinarity and values in universities

A thesis submitted for the degree of Doctor of Philosophy of
The Australian National University
April 2008

Katherine Dove Sherren
Fenner School of Environment and Society
I declare that this thesis is my own work except in one instance of co-authorship.

Collaboration with supervisor Libby Robin produced a book chapter on which Section 2.3 is based, and her contribution was most substantive in Section 2.3.1 within that. My supervisors and advisors provided comments on all or parts of the rest of the thesis, but were not otherwise collaborators in the work.

Kate Sherren
April 2008
To Simon
for making it happen;

To Reg and Ellen
for making it possible; and,

To Margaret and Rowena
for making it likely.
Acknowledgements

There are many people who have helped me through the duration of this thesis. First among them is my partner Simon Couper. Simon kept house, kept smiling, kept faith, and kept my sentences short and tenses correct. Simon’s family, the Coupers, Hackneys, Hayes and Sadlers, were loving surrogates to my own.

My primary supervisor Stephen Dovers has been unfailingly generous with his time, insights and good humour. I also cannot imagine the project without Libby Robin, who came onto the project late and initially in a role of collaborator. Her detailed eye and wide expertise (and excess time spent in airport lounges) contributed fundamentally.

Several individuals played valued advisory roles on this project, too. Linda Butler tirelessly provided bibliometric data and advice; Alden Klovahl welcomed me into his community of social network analysts; and, discussions with Stephen Kemmis on educational theory never failed to make me think harder. Malcolm Alexander taught me the essential skill of social network analysis, and provided ‘tech support’ beyond the call of duty.

Although the Centre for Resources and Environmental Studies is no more, it is this group that was the midwife of this thesis. The supportive and diverse academic community of CRES gave me a bigger perspective on the undertaking of sustainability, and the different contributions to that of disciplinary and interdisciplinary expertise. I feel such gratitude for the companionship and support of my fellow PhD students, and the early career researchers, who took the time to mentor my development and provide moral support. In particular, I would like to thank Jenny Drysdale, Ioan Fazey, Adam Felton, Annika Felton, Joern Fischer, Ben Gilna, Ari Lowe, Nicki Munro, Lisa Robins, Debbie Saunders, Jason Sharples, David Wilson, and Su Wild River.

Colleagues in the School of Resources, Environment and Society and ANUgreen have also been strong supporters of this work, especially Richard Baker, David Carpenter, Stefan Kauffman, Peter Kanowski, and Jennifer McMillin. William Adlong at Charles Sturt University in Wagga has been a valued and supportive colleague throughout.

My research participants are to be particularly thanked, including survey respondents and staff of the Canadian and Australian case universities I studied. Interviewees within each case provided candid information and valuable feedback to chapter drafts. The respective research offices provided data and explanation of the esoteric nature of publication databases. The Faculty of Science at ANU provided the funds for the Canadian travel.

Final thanks to go the tireless support staff in CRES, the efficient staff of the Human Ethics Committee, my intramural volleyball co-Velociraptors, and the welcoming staff at The God’s café.
Abstract

The United Nations declared 2005 to 2014 to be the Decade of Education for Sustainable Development. This agenda is being implemented enthusiastically in university facilities management and operations, and while research in sustainability is increasingly common, tertiary curriculum has not experienced a similar push. This thesis undertakes to explore the expressions of sustainability in the academic activities of universities, and to determine what sort of change (if any) is appropriate. It also seeks to mediate what has become a polarised debate between idealists and pragmatists around the implementation of EFS. Two key features of the work are: 1) the investigation of sustainability in the aggregate student experience, rather than individual subjects; and 2) returning to first principles to avoid a normative stance a priori.

A range of methods is employed adaptively through the process of this alternately broad and deep exploratory study, including: participant observation, interviews, content analysis, questionnaires, social network analysis, bibliometrics, and data clustering. A systemic approach to Canadian and Australian case work captures the diversity of institutional roles and academic motivations at play in adaptation to the EFS agenda.

A stasis exists between the literature around higher education curriculum for sustainability and its implementation. The problem is exacerbated by the lack of pedagogical training in most university academics. A long-standing utilitarian sectoral culture and an increasingly job-focused student market further challenge such public-good concepts as sustainability in the academy. Four simple ideas sit at the heart of 35 years of environmental and sustainability education literature, despite changes in jargon: liberal education and broad foundations; interdisciplinarity in problem-solving; cosmopolitan philosophies; and civic action. Relevant disciplinary content includes biology, environmental science, policy, philosophy, human society, economics, and culture. Most of these elements are rare in the Australian sector, which instead offers science and technology-focused environmental programs with flexible requirements. A transition to the human realm is evident in programs targeting sustainability.

Curriculum cannot be viewed in isolation, however, as it concerns only one of a university’s many constituencies, and one facet of academic staff scholarship. For example, even in higher education sectors more sympathetic to a diversity of university niches and curricular models, like Canada’s, sustainability offerings operate at a tension from low-cost and low-effort teaching models. So-called ‘umbrella’ networking structures on cross-cutting topics must walk a careful line to be comprehensive yet non-competitive. They present great opportunities for sustainability teaching but are almost uniformly research-focused. A distinct sense emerges that the erosion of the collective identity and activities of academe has weakened the ability of universities to respond to new information and challenges in anything but corporate, isomorphic ways.

Two detailed Australian cases of research, research training and curriculum development activities around sustainability paint a rich picture of the agenda. The
intractability of fragmentation between disciplines is evident, even in so-called interdisciplinary units. Problem-based topics often do not have an established social network or committee structure, and priorities can differ by budget unit. Disciplines provide identity, peers and cohesive research directions that can be compelling for individual academics. The most fascinating pattern that arises during the mapping of research co-authorship and co-supervisory relationships around sustainability is the bi-directional orientation: academics collaborate outside their departmental home on papers, but within that home to mentor research students. This combination unifies two contrasting theories of social capital transmission – those preferring dense and sparse networks, respectively – and may be ideal. Students then receive consistent messages while gaining access to the largest (non-redundant) set of human and technical resources via their supervisors’ personal networks. This hypothesis should be explored further: if supported, it would have major impacts on the rhetoric around collaboration in interdisciplinary units in particular.

Curriculum design processes in utilitarian universities are subject to the same fallibilities in adapting to sustainability as other institutions and the wider society. Change is motivated and moderated by financial imperatives and the scale of thought is often coincident with budgets. Engagement processes are often incomplete or undemocratic, hampered by inadequate leadership and shifting membership. Group learning via research, experimentation or vigorous debate is surprisingly rare. Finally, ad-hoc or project-based academic teams are rarely mandated to tackle the causes of problems, some of which can be intractable, and are limited to treating the symptoms. Incremental pragmatism may be a necessary element to university adaptation for EFS.

A number of recommendations are offered to improve interdisciplinarity and university values more generally. Individual academics should: offer additive alternatives to metrics and incentive schemes that maintain existing functions; act on common ground to rebuild a community of scholars; wield to the fullest the freedom in the classroom, and the opportunity to reflect, that university teaching allows; and, continue to debate ideas with passion and rigour, avoiding ‘academic correctness’. University management can contribute by: establishing a clear academic identity for the university beyond ‘excellence’, and supporting firm foundations for students based on that particular vision; taking a proactive view of course review and development and facilitating experimentation in those settings; intentionally fostering interdisciplinary units differently to disciplinary ones; and, establishing and recognising equivalence across a range of successful academic career archetypes.

This methodologically innovative work also suggests opportunities for extending the research, including: refining and testing the sustainability canon developed here; better understanding collaborative behaviour and the impact of various models of supervisory teams on student career paths; and, finding better ways of defining, modelling and evaluating interdisciplinary scholarship. Sustainability is likeliest to emerge from a healthy and independent tertiary sector, than one operating as an overt policy instrument.
Table of contents

Acknowledgements...........................................................................................................i
Abstract...........................................................................................................................iii
Table of contents .............................................................................................................v
List of tables...................................................................................................................vii
List of figures..................................................................................................................xi
Acronyms .......................................................................................................................xv

CHAPTER One  The context for change................................................................. 1
  1.1 Statement of the problem ............................................................................. 1
  1.2 Literature survey ......................................................................................... 1
  1.3 Research direction ....................................................................................... 24
  1.4 Research process ........................................................................................ 26
  1.5 Thesis structure and conventions ............................................................... 29

PART A: What does it mean to be educated for sustainability? ......................... 33

CHAPTER Two  A local history of sustainability and higher education .............. 35
  2.1 Why look backward? ................................................................................. 35
  2.2 Broad brush surveys of sustainability and higher education ..................... 36
  2.3 Recent history of environmental education in detail .................................. 50
  2.4 Looking back to look forward ................................................................... 55

CHAPTER Three  Key curricular concepts for sustainability............................ 57
  3.1 The sustainability canon ............................................................................ 57
  3.2 Balancing the disciplines ......................................................................... 71
  3.3 Summary of sustainability education characteristics ................................ 82

CHAPTER Four  Taking up sustainability in Australian universities ............... 85
  4.1 Where are we now? ................................................................................. 85
  4.2 Audit methods .......................................................................................... 85
  4.3 Reflections on sustainability in university coursework programs ............. 89
  4.4 Idealised vs. actual curriculum ................................................................. 102
  4.5 What’s in a name? .................................................................................. 105
  4.6 Status quo ............................................................................................... 110

CHAPTER Five  Theorising higher education....................................................... 113
  5.1 Breaking the impasse .............................................................................. 113
  5.2 New institutionalism - linking macro and micro views ............................ 116
  5.3 Resistance or resilience? ......................................................................... 118
  5.4 The view from the enterprise ................................................................. 121
  5.5 The view from academe ........................................................................ 125
  5.6 Learning to look sideways .................................................................... 128
PART B: The entropy of sustainability in universities................................. 131

CHAPTER Six  Canada: innovation under tension ...................................... 133

6.1 Sector background .................................................................................. 133
6.2 Interview methods .................................................................................. 135
6.3 Points of friction .................................................................................... 137
6.4 Conclusions ......................................................................................... 149
6.5 Addendum .............................................................................................. 151

CHAPTER Seven  Mapping collaboration in an interdiscipline .................. 157

7.1 Studying sustainability research collaboration ......................................... 157
7.2 Social networks and social capital ......................................................... 158
7.3 Collaboration within universities ............................................................ 161
7.4 Collaboration within sustainability hubs ............................................... 175
7.5 Methodological reflections ..................................................................... 191
7.6 Conclusions ......................................................................................... 197

CHAPTER Eight  Australia: fallibility in the ivory tower .......................... 199

8.1 Curriculum change in an interdiscipline ................................................. 199
8.2 Case-study methods .............................................................................. 200
8.3 Case narratives and outputs .................................................................. 204
8.4 Four contradictions of the academy under sustainability .................... 209
8.5 Epilogue .............................................................................................. 230
8.6 Conclusions ......................................................................................... 232

CHAPTER Nine  Summary and synthesis .................................................. 235

9.1 Revisiting the research questions ............................................................ 235
9.2 Methodological innovations .................................................................. 237
9.3 Recommendations .............................................................................. 238
9.4 Sustainability bound? ........................................................................... 242

References ................................................................................................. 245

Appendix: Integrative research methods curriculum .................................. 285

Course overview ....................................................................................... 287
Team-based structure ................................................................................ 288
Assessment ............................................................................................... 289
Rough outline ........................................................................................... 290
Weekly schedule ...................................................................................... 291
List of tables

Table 1.1 Summary of the Boyer Commission’s (1998) ten recommendations for transforming undergraduate education ................................................................. 4
Table 1.2 Similarity of terms and phrases found in Landmark EE and EFS documents (CERI 1973, 1976; UNESCO 2004). ........................................................................... 10
Table 1.3 Main tenets of the Talloires Declaration on Education for Sustainable Development (ULSF 1990, n.p.). ........................................................................... 12
Table 1.4 Matrix of published/in press (grey) or planned (white) research outputs to thesis chapters ........................................................................................................... 31
Table 2.1 Classification of Australian universities, from Marginson (1999). ............ 48
Table 3.1 Summary of pedagogical and normative concepts underpinning sustainability education ........................................................................................................... 58
Table 3.2 Eight key steps of integration for sustainability, broken into three stages of activity related to different kinds of integration work .............................................. 63
Table 3.3 Discipline bias demonstrated by the Hawaii cohort at each level of the RFCD classification system. Square brackets indicate that multiple subjects are chosen within the class, and contain a subject count ........................................ 75
Table 3.4 Subjects in which a high degree of agreement existed, by role, in order of priority. Percentages of consensus are given in brackets ........................................... 78
Table 3.5 Differences in nominated program size between the Halifax and Hawaii respondent populations ............................................................................................. 80
Table 4.1 Summary of audited environmental or sustainability courses, including the rationale for inclusion or culling.................................................................................. 86
Table 4.2 Australian environmental or sustainability degree programs whose core details were captured .......................................................................................... 87
Table 4.3 Sample nine-subject foundation developed from survey, and the aggregate from existing undergraduate programs. This calculation is based on a 12.5 subject core (the Australian average) but only areas that round up to at least a full subject are included in each ............................................................................................................. 105
Table 4.4 Undergraduate program clusters found, matched with classifications from the literature .................................................................................................................. 109
Table 4.5 Descriptions of graduate program classes found ........................................................................................................................................................................... 109
Table 5.1 Sequence of propositions delineating neo-institutionalism in the social sciences (Goodin 1996, p. 19-20). .......................................................................................... 116
Table 5.2 A typology of institutional change adapted from the work of Stephen Dovers and John Handmer (Dovers and Handmer 1992; Handmer and Dovers 1996)...... 119
Table 5.3 Facets of organisational learning from Garvin (1993), Huber (1991) and Dill (1999), including the relevance of each facet for higher education in Australia. … 120
Table 5.4 Three mechanisms of isomorphism in organisational fields (adapted from DiMaggio and Powell 1973), and their relevance to the Australian higher education sector: ........................................................................................................... 122
Table 6.1 Statistics on 2003 program completions, focusing on those in a broadly environmental field (Data: DEST 2005c; Statistics Canada 2005)......................134

Table 6.2 Diversity of Canadian cases by location, year of establishment as a university (and precursor institutions), rank (thirds within type), type, percent graduate and number of students (Data: individual university web sites; Council of Ontario Universities 2004; Macleans 2005; Maritime Provinces Higher Education Commission 2006; University Presidents Council of British Columbia 2005). ....136

Table 6.3 Indicative questions asked of Canadian interviewees..................................137

Table 6.4 Matrix showing Canadian cases, number of interviews, and the rationale for inclusion. ................................................................................................................151

Table 6.5 Matrix showing Canadian cases and their uses in theory building in this chapter. Zeroes indicate key cases described in greater detail in Table 6.6, Table 6.7, and Table 6.8............................................................152

Table 6.6 Canadian cases expressing environment and sustainability core content issues. ..................................................................................................................153

Table 6.7 Summary of innovative Canadian cases illustrating equity and program selectivity issues.................................................................154

Table 6.8 Summary of Canadian ‘umbrella’ institutes around sustainability..........155

Table 7.1 Data sources and periods used for analysis of two case study universities, and sustainability hubs within them. The header refers also to sections where the data is employed. ..............................................................................................................161

Table 7.2 Classes and rationales used for filtering papers and theses once extracted using keywords. Those classed with any categories marked with asterixes were removed from the analysis. .................................................................................................162

Table 7.3 Percent of collaborations of each orientation, by case and activity. Square brackets contain the results of preliminary analyses where supervision was modelled as fully connected. The entire datasets of each institution are compared, 1981-2004 for A and 1993-2004 for B.................................................................165

Table 7.4 A comparison of co-authorship patterns between raw (All) and sustainability (Sust) ISI publications, using the percentage of papers demonstrating collaborations of various types, rather than the proportion of linkages from those papers that cross each type of boundary. The categories are exclusive (save for overlaps between the composite indices), prioritising local engagement.................................................167

Table 7.5 Share of scholarly outputs from the case universities indexed by the ISI’s three databases, over the two time periods of interest.........................................167

Table 7.6 How sustainability and all ISI collaborative orientations differ, based on Table 7.4. If the number is positive, sustainability work features it more than the entire ISI set. .................................................................168

Table 7.7 Average numbers of actors per ‘sustainability’ product, by activity and case, for all years available. .........................................................................................169

Table 7.8 Statistics on shared faculty-level nodes and links (collaboration paths), as well as those only present for one of the two activities. Results in square brackets contain sums if supervision was modelled as fully connected rather than radial. ............173

Table 7.9 Comparison of actual DEST-reported points for University A’s sustainability hub, 2000-2004, with those captured by various datasets used here; 1) the culled
ISI, 2) raw ISI (both approximate), and 3) University A’s P2 database, by year. Note that computations were reached differently in each case, and are shown here as purely indicative of trajectory. The number of research outputs, budget units and authors found in each dataset are also given for comparison.................................179

Table 7.10 Comparison of DEST points for University B’s sustainability hub included in; 1) the sustainability ISI, and 2) University B’s internal database, by year. Computations were reached differently in each case, and are shown here as purely indicative of trajectory. The number of research outputs, budget units and authors found in each dataset are also given for comparison.................................180

Table 7.11 Description of clusters within University A’s sustainability hub, 2000-2004. Key nodes are present in most years and hold continuing appointments; secondary hold more temporary appointments. Individual node ID numbers correlate with those in Figure 7.10. .................................................................................................183

Table 7.12 Matrix showing the number of student supervisory panels chaired from within each cluster that included at least one member from another cluster. The diagonal is empty because connections within cluster were not captured. A directed – possibly unreciprocated – link is assumed from the chair to other supervisors. 186

Table 7.13 Description of clusters within University B’s sustainability hub, 2000-2004. using individual node ID numbers identified in Figure 7.11. Key players are divided into two groups: those acting as key nodes, and those with lower ‘degree’, often playing connecting roles. The nodes given in italics are female; the rest are male. ................................................................................................................................187

Table 7.14 Matrix containing numbers of supervisors from the same and other clusters, as well as from outside the AOU, for research student theses chaired at the hub AOU that were completed between 2000 and 2004, inclusive. A directed – possibly unreciprocated – link is assumed from the chair to other supervisors. ..................189

Table 7.15 Summary and comparison of collaborative relationships inside sustainability hubs at both case universities, 2000 to 2004, based on analyses performed in Section 7.4.2. ..........................................................................................................190

Table 7.16 Gender equity in sustainability hubs, 2000-2004, and case universities overall in 2003 (source for latter: internal university statistics).............................191

Table 7.17 Conversion table for ensuring sociogram publication links sum to the DEST-value. Totals of ‘points per author’ are shown in scaled node sizes; ‘points per link’ by weighted lines....................................................................................................196

Table 8.1 Overview of the Australian case processes...................................................203

Table 8.2 Guiding questions for the interview process. M indicates the question was only asked of managers overseeing the process, P indicates it was asked only of participants, M/P indicates it was asked of both. Not all questions were asked of all interviewees, and phrasing varied by subject .........................................................204

Table 8.3 Summary of case processes followed. ..........................................................204

Table 8.4 Reflections from University A interviewees about the curriculum developed together...................................................................................................................209

Table 8.5 Comments from interviewees about declining resources as a rationale for change........................................................................................................212

Table 8.6 Comments from University A interviewees about meeting management expectations as a rationale for change............................................................213
Table 8.7 Comments from University B interviewees demonstrating a lack of consistency resulting from diverse sets of instructions. 217

Table 8.8 Participant types in University A curriculum change process. 219

Table 8.9 Comments from interviewees demonstrating a lack of research into student outcomes. 221

Table 8.10 Comments from University A interviewees about the degree of rigorous debate involved in the case processes. 225

Table 9.1 Methods employed in the thesis in relation to the research questions they answered, and the chapters in which the relevant work is discussed. 237
List of figures

Figure 1.1 NSW Year 12 higher school certificate enrolments in geography, 1991 to 2004, showing the ratio of those choosing final year study in the topic compared to those who opted in the previous year (Data: NSW Board of Studies 2005)........22

Figure 1.2 Thesis structure, showing the elements of the research process. Light gray boxes indicate Part A of the thesis, covering context, and darker gray represents the Part B case work..............................................................29

Figure 2.1 The time periods used in this chapter, in relation to national population and university expansion (data source: ABS 2005, individual university websites).....36

Figure 2.2 Supply and demand of environmental courses in Australia. Pre-2001, the discipline of environmental science is used, post-2001, environmental studies (data: custom DEST statistics)..........................................................53

Figure 2.3 Supply and demand of geography courses in Australia. Pre-2001, the discipline of geography is used, post-2001, human geography (data: custom DEST statistics)...................................................................................54

Figure 2.4 The average market share based on enrolments in each discipline and level divided by the number of ‘active’ programs (those having one or more students enrolled per year) (data: custom DEST statistics)....................................................54

Figure 3.1 The dimensions and scales of the human sphere of influence and interests, or citizenships, through time.........................................................................................66

Figure 3.2 Questionnaire used at two sustainability conferences to elicit ‘ideal’ sustainability curriculum content. ....................................................................................72

Figure 3.3 Entity relationship diagram representing the survey database in Microsoft Access......................................................................................................................73

Figure 3.4 RFCD discipline coverage of Hawaii and Halifax survey respondents. Black bars denote the discipline is within the respondent’s academic unit (if they work in a university); gray bars indicate that the respondent’s highest degree is in that field. Multiple counts are possible for an individual in each category..............................74

Figure 3.5 The popularity of various RFCD divisions in curricula nominated by respondents, listed in order of their nomination as core...........................................77

Figure 3.6 Popularity of pedagogical methods for undergraduate sustainability education, derived from a content analysis of questionnaires............................................79

Figure 3.7 The Halifax and Hawaii a) core and b) elective programs in comparison, ordered by the difference between the two aggregates produced. .........................81

Figure 4.1 Entity relationship diagram for Microsoft Access audit database............86

Figure 4.2 Raw counts of courses and subjects with core content in three levels of RFCD fields.................................................................88

Figure 4.3 Number of faculties with sustainability content mapped against the number of faculties in the university, as of 2005. Some university web sites were designed such that a comprehensive survey can not be guaranteed, so the results are separated accordingly..........................90
Figure 4.4 Integration of sustainability subjects across universities, as indicated by counts of sustainability subjects, stacked by faculty. Those shown in gray did not have comprehensive online search functionality.

Figure 4.5 The location of the keyword ‘sustainab*’ in subject listings at Australian universities. The bottom half of the list may be incomplete as a result of online search functionality.

Figure 4.6 Content analysis showing the prevalence of keywords describing a liberal education in generalist core curriculum and sustainability subjects captured during the audit.

Figure 4.7 Division level popularity by core subject count, dividing courses that explicitly mention sustainability in name or web marketing, from those that do not. RFCD divisions are ordered by the total times used by the full set of courses.

Figure 4.8 Scatterplots demonstrating the range of course structures and subject diversity in audited programs. The first graph (a) shows the relationship between core size and disciplinary breadth, using the incidence of RFCD divisions. The second (b) shows the number of subjects included in the most dominant division as mapped against the number in the second, showing the degree to which one division often dominates.

Figure 4.9 Content analysis of core and sustainability subject descriptions for various terms for cross-disciplinarity.

Figure 4.10 Content analysis of core and sustainability subject descriptions for various terms for cross-disciplinarity, mapped against the year of the subject as indicated by the subject number.

Figure 4.11 Prevalence of disciplines contributing to cosmopolitan world views in core subjects (description or classification area), sustainability subjects, or available major streams or specialisations.

Figure 4.12 Prevalence of temporal scale keywords in core and sustainability subject titles and descriptions.

Figure 4.13 Geographical scale of curriculum content as a proxy for cosmopolitanism in all core curriculum and sustainability subjects audited.

Figure 4.14 Content analysis showing the elements of civics in all core curriculum and sustainability subjects audited, as well as available specialisations and majors of audited programs.

Figure 4.15 Aggregate survey curriculum as compared with aggregates generated from Australian environmental and sustainability programs.

Figure 4.16 Number of core subjects in each division in aggregates based on survey and actual Australian undergraduate courses. The eight percent gridlines demarcate ‘one subject’ thresholds.

Figure 4.17 Average undergraduate program core contents by course name, noting the number of such programs captured, and the mean number of subjects stipulated for each group.

Figure 4.18 Average graduate program core contents by course name, noting the number of such programs captured, and the mean number of subjects stipulated for each group.

Figure 4.19 Seeking the elbow criterion. The number of classes used in k-means clustering for the undergraduate and graduate courses, mapped against the percent
of the variance in the data sets that exists between clusters. This is the inverse of
that within clusters, in which a low value indicates higher homogeneity........108

Figure 5.1 The duality of structuration processes (adapted from Giddens 1979, pp. 66,
71)...........................................................................................................................117

Figure 6.1 Core curriculum structural types, supported by examples encountered in case
work................................................................................................................................138

Figure 6.2 Four Canadian environmental program cores, as classified using the
Australian Research Council’s RFCD (research field, courses and disciplines)
system. Three credits equal one subject, one-fifth of a typical semester’s load.
(Source: individual university course materials, as of September/October 2005.) 143

Figure 7.1 Graphical representation of the culling rationale explained in Table 7.2.
Those theses and publications classified with the combinations represented in gray
were retained. .........................................................................................................163

Figure 7.2 Number of research activities used in this analysis, over time and by case, as
extracted from ISI databases and internal university graduate student records, and
filtered for relevance to sustainability....................................................................163

Figure 7.3 The relationship between the number of people involved in an academic
product and the number of mutual links, using fully connected and radial or ego-
based approaches....................................................................................................164

Figure 7.4 Percent of ‘links’ of each type, by case and activity (as in Table 7.3), but
counting solo publications as links. Note that supervision always involves at least
one supervisor, so no solo links are present in that category. .........................165

Figure 7.5 Internal collaborative relationships at University A represented by discipline
areas rather than identifiable unit names: a) Co-authorships in sustainability ISI
papers, 1980-2004, scaled by the number of time each AOU appeared on a paper,
with link weights representing the frequency with which the two nodes appeared
together; and, b) Co-supervisory relationships, 1976-2005, with nodes weighted by
the number of students or supervisors from that AOU named on a relevant culled
thesis, and links demonstrating the frequency of the pair....................................171

Figure 7.6 Internal collaborative relationships at University B represented by campus
and discipline areas rather than identifiable unit names: a) Co-authorships in culled
ISI papers, 1993-2004, scaled by the number of time each AOU appeared on a
paper, with link weights representing the frequency with which the two AOUs
appeared together; and, b) Co-supervisory relationships, 1990-2005, with nodes weighted by
the number of students or supervisors from that AOU named on a relevant culled
thesis, and links demonstrating the frequency of the pair.................................172

Figure 7.7 Multiplex nodes and links (those which are present for both co-authorship
and co-supervision) for each case university, scaled and weighted by the number of
total activities and links. Black nodes are members of that university’s ‘umbrella’
organisation: a) In the case of A, all umbrella units have multiplex involvement and
thus are represented here; b) for B, the two relevant umbrella groups (Sustainability,
Rural Society) are not formalised to the degree that they are valid AOUs for
supervisors. Formal budget units are credited for supervisory activities instead at B,
which largely align with C3-Environment/IT and C1-Arts/Social Sci respectively.
....................................................................................................................173

Figure 7.8 A scatterplot indicating the number of AOUs involved in publications and
research panels on sustainability each year, at a) University A, and b) University B.
....................................................................................................................174
Figure 7.9 Aggregated ego collaborative maps of a) University A and b) University B, 2000-2004, scaled by DEST point contribution to hub publications. Nodes are scaled by the number of DEST points that other departments contributed to hub publications, ranging up to 6.8 for A and 3.3 for B. The hubs themselves are not scaled because their large size would make the rest so small as to make it hard to distinguish between contributions. Line weights indicate the DEST value shared between the nodes on those same hub publications. ‘Unknown’ in B contains statistical consultants.

Figure 7.10 Co-publication collaborations within the University A sustainability hub, 2000-2004, grouped into disciplinary or problem clusters. Colouring is by sex (men are gray, women black); squares indicate key or secondary nodes; size indicates the share of DEST points produced by the author, and links are weighted by the proportion of DEST work shared by the nodes. Note that some individuals (often departmental visitors) have not participated in research clusters.

Figure 7.11 Copublication collaborations within the University B sustainability hub, 2000-2004, grouped into disciplinary or problem clusters. Shading is by umbrella centre membership (sustainability is black, complex systems gray and those without affiliation are white); shapes indicate dominance (squares are key players or their primary collaborators; circles are all others); node size is scaled by the share of DEST points produced by author, and links are scaled by the cumulative proportion of DEST work shared by the nodes.

Figure 7.12 ISI coverage of DEST output, by field, adapted from Butler and Visser (2006, p. 329). Human society includes sociology, social work, anthropology, human geography and demography.

Figure 8.1 Schematic of core curriculum designed by, a) University A, and b) University B. The bottom row represents first year, the middle, second, and the third, the final year before honours. Subject choice is available in light gray areas (with the number of options in brackets); darker gray represents optional content.

Figure 8.2 Enrolments in environmental programs, 1989-2003, as reported to DEST, for a) postgraduate (including by research), and b) undergraduate study. University B’s internal numbers (black dashed line) differed from those reported to DEST (solid black line), so both are given. Between 2000 and 2001, DEST changed classification systems; numbers given are for Environmental Science until 2000; environmental studies afterwards.

Figure 8.3 A schematic model of University B’s new, post-case Environmental Science program.
### Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAC&amp;U</td>
<td>Association of American Colleges and Universities</td>
</tr>
<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
</tr>
<tr>
<td>ACF</td>
<td>Australian Conservation Foundation</td>
</tr>
<tr>
<td>ACTS</td>
<td>Australasian Campuses Towards Sustainability</td>
</tr>
<tr>
<td>ANU</td>
<td>Australian National University</td>
</tr>
<tr>
<td>AOU</td>
<td>Academic organisational unit</td>
</tr>
<tr>
<td>ARC</td>
<td>Australian Research Council</td>
</tr>
<tr>
<td>ARIES</td>
<td>Australian Research Institute in Education for Sustainability</td>
</tr>
<tr>
<td>AUCC</td>
<td>Association of Universities and Colleges of Canada</td>
</tr>
<tr>
<td>AVCC</td>
<td>Australian Vice Chancellor’s Committee (now Universities Australia)</td>
</tr>
<tr>
<td>AUQA</td>
<td>Australian Universities Quality Agency</td>
</tr>
<tr>
<td>CAE</td>
<td>College of Advanced Education</td>
</tr>
<tr>
<td>CERI</td>
<td>Centre for Educational Research and Innovation (OECD)</td>
</tr>
<tr>
<td>CRC</td>
<td>Cooperative Research Centre</td>
</tr>
<tr>
<td>CSIR</td>
<td>Council for Scientific and Industrial Research (precursor to CSIRO)</td>
</tr>
<tr>
<td>CSIRO</td>
<td>Commonwealth Scientific and Industrial Research Organisation</td>
</tr>
<tr>
<td>DEST</td>
<td>Department of Education, Science and Training</td>
</tr>
<tr>
<td>DVC</td>
<td>Deputy Vice-Chancellor – denotation of (A) refers to an Academic DVC</td>
</tr>
<tr>
<td>ECR</td>
<td>Early career researcher</td>
</tr>
<tr>
<td>EE</td>
<td>Environmental education</td>
</tr>
<tr>
<td>EFS</td>
<td>Education for sustainability</td>
</tr>
<tr>
<td>EM</td>
<td>Environmental management</td>
</tr>
<tr>
<td>EIANZ</td>
<td>Environment Institute of Australia and New Zealand</td>
</tr>
<tr>
<td>ESD</td>
<td>Ecologically sustainable development</td>
</tr>
<tr>
<td>ESDRC</td>
<td>Environment and Sustainable Development Research Centre (UNB)</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic information systems</td>
</tr>
<tr>
<td>GNI</td>
<td>Gross national income</td>
</tr>
<tr>
<td>HEP</td>
<td>Higher education provider</td>
</tr>
<tr>
<td>HERDC</td>
<td>Higher Education Research Data Collection</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and communication technologies</td>
</tr>
<tr>
<td>Acronym</td>
<td>Full Form</td>
</tr>
<tr>
<td>---------</td>
<td>-----------</td>
</tr>
<tr>
<td>IRES</td>
<td>Institute for Resources, Environment and Society (UBC)</td>
</tr>
<tr>
<td>IRIS</td>
<td>Institute for Research and Innovation in Sustainability (York University)</td>
</tr>
<tr>
<td>ISI</td>
<td>Institute for Scientific Information</td>
</tr>
<tr>
<td>MDG</td>
<td>Millennium Development Goal</td>
</tr>
<tr>
<td>MEA</td>
<td>Millennium Ecosystem Assessment</td>
</tr>
<tr>
<td>MTA</td>
<td>Mount Allison University</td>
</tr>
<tr>
<td>NRM</td>
<td>Natural resource management</td>
</tr>
<tr>
<td>NSW</td>
<td>New South Wales</td>
</tr>
<tr>
<td>NSW CEE</td>
<td>NSW Council on Environmental Education</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
</tr>
<tr>
<td>OED</td>
<td>Oxford English Dictionary</td>
</tr>
<tr>
<td>RFCD</td>
<td>Research Fields, Courses and Disciplines</td>
</tr>
<tr>
<td>RMIT</td>
<td>Royal Melbourne Institute of Technology</td>
</tr>
<tr>
<td>RQF</td>
<td>Research Quality Framework</td>
</tr>
<tr>
<td>SFU</td>
<td>Simon Fraser University</td>
</tr>
<tr>
<td>SNA</td>
<td>Social network analysis</td>
</tr>
<tr>
<td>STU</td>
<td>St. Thomas University</td>
</tr>
<tr>
<td>TAFE</td>
<td>Technical and Further Education</td>
</tr>
<tr>
<td>TER</td>
<td>Tertiary Entrance Rank</td>
</tr>
<tr>
<td>TOR</td>
<td>Terms of reference</td>
</tr>
<tr>
<td>UBC</td>
<td>University of British Columbia</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>ULSF</td>
<td>University Leaders for a Sustainable Future</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>UNS</td>
<td>Unified National System</td>
</tr>
<tr>
<td>UNB</td>
<td>University of New Brunswick</td>
</tr>
<tr>
<td>UNEP</td>
<td>UN Environment Programme</td>
</tr>
<tr>
<td>UNESCO</td>
<td>UN Education, Scientific and Cultural Organisation</td>
</tr>
<tr>
<td>US</td>
<td>United States</td>
</tr>
<tr>
<td>VC</td>
<td>Vice-Chancellor</td>
</tr>
<tr>
<td>WCED</td>
<td>World Commission on Environment and Development</td>
</tr>
</tbody>
</table>