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An evaluation of the Australian Research Council's journal ranking

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ABSTRACT

As part of its program of 'Excellence in Research for Australia' (ERA), the Australian Research Council ranked journals into four categories (A*, A, B, and C) in preparation for their performance evaluation of Australian universities. The ranking is important because it likely to have a major impact on publication choices and research dissemination in Australia. The ranking is problematic because it is evident that some disciplines have been treated very differently than others. This paper reveals weaknesses in the ERA journal ranking and highlights the poor correlation between ERA rankings and other acknowledged metrics of journal standing. It highlights the need for a reasonable representation of journals ranked as A* in each scientific discipline.

1. Introduction

In 2008, the Australian Government announced its *Excellence in Research for Australia* (ERA) initiative to assess research quality within Australia's higher education institutions using a combination of indicators and expert review (Anonymous, 2009). One of the indicators is a discipline-specific journal ranking (Anonymous, 2010a), despite limitations of this approach (Bollen, Van de Sompel, Hagberg, & Chute, 2009; Butler, 2003a; Lamp, 2009; Northcott & Linacre, 2010). This ranking of journals has not been universally welcomed (e.g., Peters, 2008), and this contribution seeks to evaluate whether the ranking released in February 2010 is equitable across disciplines. Others have considered various aspects of expert review and esteem indicators (e.g., Atkinson, 2010; Donovan & Butler, 2007; Genoni & Haddow, 2009; Jarwal, Brion, & King, 2009), so this study confines itself to an analysis of the journal ranking across disciplines. Such analyses are important to maintain the objectivity of the ERA system, because the draft ranking attracted the observation that "it is plausible to suggest that some degree of game playing may have taken place in the journal selection and allocation process. That is, some academics may have, on occasion, mixed their university specific role with their broader collegial duties" (Anderson & Tressler, 2009). This study compares the ERA ranking across all disciplines and within selected disciplines, and complements other within-discipline studies (Haddow & Genoni, 2010; Haslam & Koval, 2010).

2. The distribution of journals by 2-digit FOR division

The ERA ranking allocates 20,712 journals into four quality categories, A*, A, B, and C, in such a way that A* should represent the top 5% of journals, A should include the next 15%, B the next 30%, and C the remaining 50% of journals (Graham, 2008). The ERA also draws on 2-digit divisions and 4-digit groups of the Australian and New Zealand Standard Research Classification (ANZSRC, 2008) known as Field of Research (FOR) codes. Given that each of the FOR divisions included at least 164 journals

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(in the case of *05 Environmental Sciences*), and averaged 888 journals per division, it seems reasonable to assume that the distribution of journals within each 2-digit FOR division should approach the nominal 5:15:30:50. However, this is not the case for the 2010 journal list (Anonymous, 2010b): Table 1 shows how journals are distributed across the 4 categories within 24 disciplines (23 FOR divisions plus the ERA Multidisciplinary category), using only the primary FOR code to avoid double-counting (some journals were assigned 2 or 3 FOR codes), and omitting unranked journals.

ERA announcements prescribed a distribution of 5:15:30:50, corresponding to cumulative percentages of 5, 20, 50, and 100%, close to what is observed across all divisions (Table 1, bottom line), but some highlighted FOR divisions depart significantly from this trend. One FOR division *12 Built Environment and Design* has significantly more A and A* journals than expected, and *07 Agricultural and Veterinary Sciences* has significantly fewer A and A* journals than expected. A χ^2 test suggests that the distribution across all FOR divisions is inequitable ($\chi^2_{69} = 547, P < 0.0001$). The particularly high representation (15% and 24%) of A* and A journals in *12 Built Environment and Design* appears to be the successful result of an orchestrated campaign (Friedman et al., 2008). Table 1 considers only the primary FOR code, overlooks secondary and tertiary FOR codes (15% of journals had 2 or 3 FOR codes in a FOR division other than the primary division), and considers only the 2-digit FOR division rather than the 4-digit FOR group. Although this simplifying assumption involves about 15% of journals, it is not sufficient to explain the inequalities in Table 1. A finer-grained analysis reveals greater inequalities.

An analysis of 4-digit FOR groups (including secondary and tertiary FOR codes) reveals that 33% of the 43 journals in *1203 Design Practice and Management* are ranked A*, whereas 0% of the 85 journals in *0705 Forestry Science* are ranked A*. These two FOR groups reflect two extremes, but are not unique, and about one quarter of the 4-digit FOR groups have no A* journals, an unhappy and inequitable situation for any field of research. Thus a more detailed examination of these two FOR groups (*0705 Forestry* and *1203 Design*) is warranted.

3. Why are there no A* journals in *0705 Forestry Science*?

The ERA ranking was based on expert consultation and review by the 'Learned Academies' (Australian Academy of the Humanities, Academy of Social Sciences in Australia, Australian Academy of Science, Australian Academy of Technological Sciences and Engineering; Anonymous, 2010c, lending to the belief that it should be fair and reasonable. Perhaps the apparent discrepancy is Table 1 is warranted, because a discipline (in this case, *0705 Forestry*) does not attain the expected quality? One way to test for this possibility is to examine where well-cited forestry papers are published, and to compare the classifications of their host journals.

A Scopus search for items with the keyword 'forestry' or 'silviculture', published during the ERA census period 2003–08 returned 25198 documents. The most-cited 5% (1260) of these papers appeared in 200 journals, of which all but 29 journals hosted fewer than 10 of these highly cited papers. These 29 journals are shown in Table 2, ranked by number of citations received. Table 2 shows that highly cited forestry papers appear in A* journals across a wide range of FOR codes, suggesting that the ERA ranking and not the forestry discipline is underperforming. Nine of the journals carried half of the most-cited papers (624 out of the 1260 articles); three of these are classified as *0705 Forestry* journals (*Forest Ecology and Management, Canadian Journal of Forest Research, Forest Science*), all ranked A, whereas all the remaining journals were ranked A* (except

Table 1
Cumulative percentage of journals in ERA categories by 2-digit FOR division.

2-Digit FOR division	A*	A	B	C
01 Mathematical Sciences	7	25	53	100
02 Physical Sciences	8	27	55	100
03 Chemical Sciences	8	24	49	100
04 Earth Sciences	5	22	47	100
05 Environmental Sciences	2	16	45	100
06 Biological Sciences	6	18	41	100
07 Agricultural and Veterinary Sciences	**1**	**12**	**34**	100
08 Information and Computing Sciences	7	24	52	100
09 Engineering	7	24	53	100
10 Technology	2	18	44	100
11 Medical and Health Sciences	4	16	39	100
12 Built Environment and Design	**15**	**39**	**60**	100
13 Education	3	16	48	100
14 Economics	7	24	51	100
15 Commerce, Management, Tourism and Services	5	17	46	100
16 Studies in Human Society	4	21	51	100
17 Psychology and Cognitive Sciences	4	20	50	100
18 Law and Legal Studies	4	17	45	100
19 Studies in Creative Arts and Writing	6	23	51	100
20 Language, Communication and Culture	5	20	50	100
21 History and Archaeology	3	23	59	100
22 Philosophy and Religious Studies	4	22	54	100
MD Multidisciplinary	5	17	43	100
Overall	5	20	48	100

Table 2
Journals publishing at least 10 of the most highly cited papers in forestry from 2003 to 08. Gap after line 9 denotes the 9 journals that carry half of the most-cited articles.

Source	FOR Code	ERA Rank	Papers	Total cites	Scopus	
					h-index	SNIP
Forest Ecology and Management	**0705**	**A**	248	9542	71	1.70
Science	MD	A*	58	6863	596	7.72
Remote Sensing of Environment	09	A*	110	4805	92	3.34
Canadian Journal of Forest Research	**0705**	**A**	77	2838	60	1.20
Nature	MD	A*	21	1976	610	10.69
Soil Biology and Biochemistry	05	A*	40	1671	82	2.10
Geophysical Research Letters	04	A*	23	1155	106	1.86
Environmental Pollution	MD	A	24	1012	75	2.19
Forest Science	**0705**	**A**	23	963	39	1.36
Trees – Structure and Function	**0705**	**B**	26	895	37	1.10
Atmospheric Environment	09	A	19	870	102	2.04
Soil Science Society of America Journal	07	A	18	660	74	2.07
Journal of Forestry	**0705**	**B**	15	638	32	1.20
Canadian Journal of Remote Sensing	09	B	11	631	29	0.61
Conservation Biology	05	A*	15	629	99	2.69
Biomass and Bioenergy	09	A	12	625	51	2.29
Plant Journal	06	A*	12	594	124	2.77
Proc. National Academy of Sciences	MD	A*	10	570	390	3.61
Climatic Change	04	A	14	560	66	1.86
Journal of Hydrology	04	A*	12	556	76	2.19
Scandinavian Journal of Forest Research	**0705**	**B**	11	522	31	0.86
Plant Physiology	06	A*	13	498	132	2.92
International Journal of Remote Sensing	09	B	15	493	71	1.17
Landscape and Urban Planning	09	A	13	484	43	2.17
Applied and Environmental Microbiology	06	A*	11	464	159	2.15
Environmental Science and Technology	MD	A*	13	443	152	2.62
Journal of Experimental Botany	06	A	10	404	88	2.16
IEEE Trans. Geoscience &Remote Sensing	04	A	10	391	86	3.19
Ecological Modelling	05	A	10	374	69	1.44

Environmental Pollution, ranked A). Scopus, the official data provider to ERA, also provides other metrics of journal performance, and the h-index (Hirsch, 2005) and SNIP (Source Normalized Impact per Paper; Moed, 2010) are included in Table 2 for comparison.

Of the 894 highly cited papers listed in Table 2, about half (47%) appear in journals classified as *0705 Forestry* (Table 3). Amongst the papers appearing in forestry (0705) journals, 88% appear in four journals ranked as A, whereas amongst papers published outside of forestry (i.e., FOR code other than 0705), 71% appear in 12 journals all ranked as A* (Table 3). Fisher's exact test for the 2 × 2 contingency table (0705 vs. other; A* vs. other) supports the notion that forestry journals are undervalued ($P = 0.023$).

There is a tendency (as expected) for the ERA rank to decline with position in Table 2, with more A* journals at the top, and fewer at the bottom of the table. This trend is more evident when ERA rank (expressed as the percentile at the class midpoint, A* = 0.975, A = 0.875, B = 0.65) is plotted against journal rank based on total citations (Fig. 1, *Forest Ecology and Management* = 1, *Ecological Modelling* = 29). When plotted in this way, it is clear that some journals (those categorised by ERA as multidisciplinary, *04 Earth Sciences*, *05 Environmental Sciences* and *06 Biological Sciences*) are more likely to be ranked A* than those categorised as *07 Agriculture and Veterinary Sciences* or *09 Engineering*, and that they 'hold their value better' with increasing rank (Fig. 1).

4. Why are there so many A* journals in *1203 Design Practice and Management*?

The discipline *1203 Design* is more difficult to analyse, because it lacks unique and distinctive keywords such as "silviculture". However, a Scopus search of the 42 journals classified as *1203 Design* reveals that three distinctive keywords were

Table 3
ERA-ranking of journals publishing the most-cited forestry papers 2003–08.

ERA category	No of journals				No of papers				No of citations received			
	A*	A	B	Tot	A*	A	B	Tot	A*	A	B	Tot
MD	4	1		5	102	24		126	9852	1012		10,864
04,05,06	7	4		11	126	44		170	5567	1729		7296
07		4	3	7		366	52	418		14,003	2055	16,058
09	1	3	2	6	110	44	26	180	4805	1979	1124	7908
Subtotal	12	12	5	29	338	478	78	894	20,224	18,723	3179	42,126

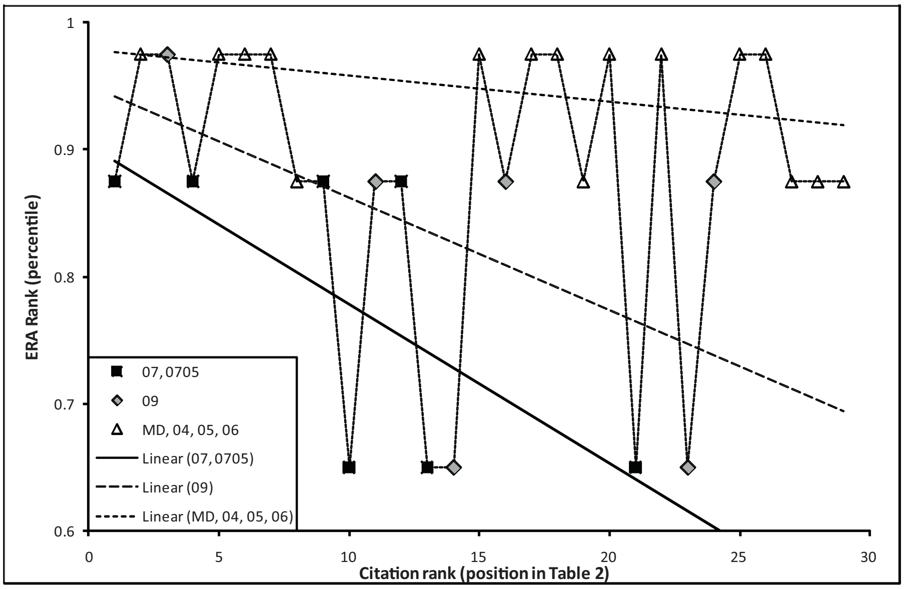

Fig. 1. ERA rank (percentiles, A* = 0.975, A = 0.875, B = 0.65) versus citation rank (total citations to journals bearing papers with keywords 'forestry' or 'silviculture', see Table 2). Journals categorised as 0705 Forestry (black squares, solid line) have a lower ERA rank despite a comparable citation count.

prevalent (ergonomics, biomechanics, and kinematics), and that the bulk of publications were classified by Scopus into four subject categories (Engineering, Computer Science, Social Science, Arts and Humanities). A subsequent search constrained to these subject categories and keywords, and the ERA census period 2003–08 recovered more papers classified as engineering (09) than *1203 Design* (Table 4), but confirmed similar journal rankings within these two disciplines, and illustrated how this search approach (5% of the most highly cited papers) successfully identifies many A*-ranked journals.

Because the keyword search reported in Table 4 returned relatively few journals classified as *1203 Design*, it is worth examining citation rates within all journals classified as *1203 Design* (Lamp, 2010a). Table 5 shows the journals with at least 10 of the papers that were amongst the 312 most-cited 5% of articles during 2003–08 in the FOR *1203 Design*. Many of these journals are ranked A*, and half of these papers were published in two journals, *Journal of Mechanical Design* ranked A* and *Computer Aided Design* ranked A (a similar analysis for *0705 Forestry* also reveals that half of the most-cited articles appear

Table 4
Journals publishing at least 10 of the most highly cited papers with keywords ergonomics, biomechanics, or kinematics. Gaps after line 12 of table denotes the 12 journals that carry half of the most-cited articles.

Source	Papers	Total cites	FOR code	ERA rank	Scopus	
					h-index	SNIP
Biomaterials	77	3935	09	A*	133	4.06
Journal of Biomechanical Engineering	75	2824	09	A	58	1.19
Science	60	6465	MD	A*	596	7.72
Proceedings of the National Academy of Sciences	54	3494	MD	A*	390	3.61
Annals of Biomedical Engineering	46	1794	09	A*	53	1.14
Journal of Biomedical Materials Research – Part A	44	1709	09	A*	49	1.30
Nature	44	4033	MD	A*	610	10.69
Ergonomics	**33**	**1020**	**1203**	**A**	**45**	**1.49**
Journal of Mechanical Design	**32**	**1247**	**1203**	**A***	**46**	**3.16**
International Journal of Plasticity	20	822	09	A	53	4.10
IEEE Transactions on Robotics and Automation	19	1129	09	B		
Mechanism and Machine Theory	19	680	09	A	36	3.45
Applied Ergonomics	**18**	**484**	**1203**	**A***	**32**	**1.71**
IEEE Transactions on Robotics	17	572	09	A*	30	3.89
Acta Biomaterialia	16	684	09	A	26	1.57
IEEE Transactions on Biomedical Engineering	16	661	09	A*	76	2.00
Human Movement Science	14	437	09	B	35	1.75
J. Biomed. Materials Research – B Appl. Biomaterials	12	431	09	A	31	1.04
Annual Review of Biomedical Engineering	11	715	09	A	55	1.40
Biomechanics and Modelling in Mechanobiology	11	397	09	C	16	1.22
Journal of Fluid Mechanics	11	365	09	A*	90	2.33
Journal of the Mechanics and Physics of Solids	11	505	09	A*	79	2.57
ACM Transactions on Graphics	10	606	08	A*	76	7.67

Table 5
Selected journals classified as 1203 Design Practice and Management and publications during 2003–08.

Journals with ≥10 of the most-cited 5% of articles	ERA rank	Amongst top 5%		Scopus	
		Papers	Cites	h-index	SNIP
Journal of Mechanical Design	A*	82	3389	46	3.16
Computer Aided Design	A	81	3189	51	3.57
Journal of Product Innovation Management	A*	39	1484	47	2.91
Ergonomics	A	33	1055	45	1.49
Interacting with Computers	B	20	691	27	2.38
Environment and Planning B: Planning and Design	A*	12	479	33	1.25
Applied Ergonomics	A*	17	474	32	1.71
Design Studies	A*	11	454	30	2.37
A* journals with ≤11 of the most-cited 5% articles		In total		Scopus	
		Papers	Cites	h-index	SNIP
Design Studies	A*	189	1490	30	2.37
Research in Engineering Design	A*	87	763	27	2.28
Journal of the Textile Institute	A*	242	452	16	0.75
Leonardo	A*	393	243	6	0.19
Journal of Design History	A*	126	130	5	1.12
Design Issues	A*	122	114	4	0.72
Fashion Theory – Journal of Dress Body and Culture	A*	169	114	4	0.42
Digital Creativity	A*	96	75	3	0.37
J. Textile Institute Part 1: Fibre Science and Textile Tech.	A*	48	54		
Winterthur Portfolio	A*	44	10	3	1.13

in two journals, *Forest Ecology and Management* and *Agricultural and Forest Meteorology*, both ranked A). Clearly, some of the *1203 Design* journals warrant an A* classification as they carry contributions comparable to A*-ranked peers in the 09 Engineering discipline. However, not all the A*-ranked journals in *1203 Design* rate so well: for instance, Scopus records that over 66% of papers published during 2003–08 in the A* journals *Leonardo* and *Winterthur Portfolio* remain uncited (in sources visible to Scopus), suggesting that these journals are in a different league to the journals listed in Table 4, all of which have non-citation rates below 30%. Others (Oswald, 2007; Singh, Haddad, & Chow, 2007; Starbuck, 2005) have noted a high frequency of uncited papers in other prestigious journals.

In both cases (*0705 Forestry* and *1203 Design*), the two top journals carry more than half of the papers that are frequently cited (in the top 5% of the most-cited papers). In both cases, frequently cited papers tend to average about 37 citations/paper (as at October 2010, to papers published 2003–08). But in the case of *1203 Design*, half of these citations accrued to journals ranked by ERA as A*, whereas in *0705 Forestry* there are no A* journals, so 82% of citations accrued to journals ranked as A (Table 6). This discrepancy warrants further examination.

5. Comparing two Fields of Research: *0705 Forestry* and *1203 Design*

Tables 1 and 6 suggest some weaknesses in the ERA ranking, so further examination with independent yardsticks is warranted. One possibility is the Hirsch (2005) h-index, devised for individuals, but which can also be applied to journals (Braun, Glänzel, & Schubert, 2006; Harzing & van der Wal, 2009; Vanclay, 2008a). Norris and Oppenheim (2010) have shown that individual ranking by peer assessment is generally well-correlated with the h-index. The journal h-index used here was derived from Scopus data 1996–2009 (via SCImago, 2010): the long time interval 1996–2009 avoids some issues of size dependence (Van Raan, 2006), but disadvantages newly established journals. Nonetheless, the graph of h-index versus the ERA category is insightful (Fig. 2), and similar to the corresponding graph of ERA rank versus SCImago Journal Rank (Gonzalez-Pereira, Guerrero-Bote, & Moya-Anegon, 2010).

Fig. 2 offers several insights. The classification of *1203 Design* journals (+, dashed line) shows a low correlation (0.11) with h-index, and examples of both low and high h-indices may occur in any of the 4 categories. In contrast, the classification of

Table 6
Frequently cited papers and the ERA rankings of the journals in which they appeared.

ERA rank	0705 Forestry Science				1203 Design Practice and Management			
	Papers	Cites	%	Cites/paper	Papers	Cites	%	Cites/paper
A*					173	6650	54	38
A	819	30,144	82	37	127	4830	40	38
B	133	4627	13	35	20	691	6	35
C	52	1703	5	33	1	22	0	22
Total	1004	36,474		36	321	12,193		38

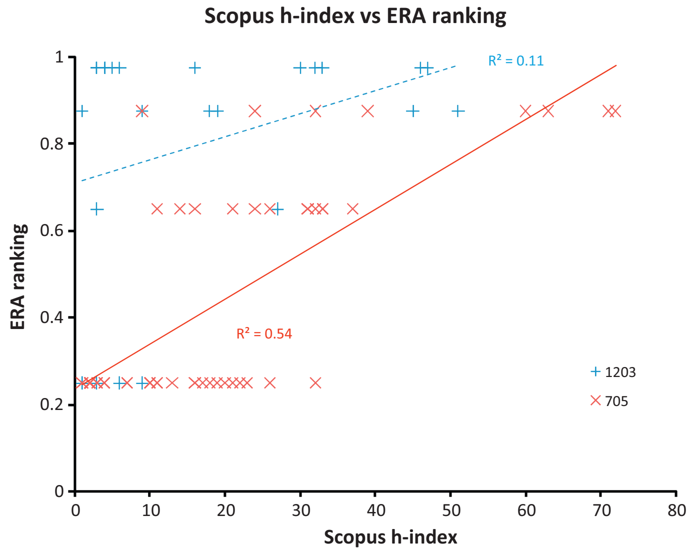

Fig. 2. Scopus h-index versus ERA category (A* = 0.975, A = 0.875, B = 0.65, and C = 0.25).

the *0705 Forestry* journals (×, solid line) shows a higher correlation (0.54) with h-index. Of greater concern is that several A-ranked journals within *0705 Forestry* have higher h-indices that A* journals within *1203 Design*, and the linear trend indicates that *0705 Forestry* journals tend to have a substantially higher h-index across all categories (i.e., the solid line is further to the right than the dashed line). The two trends differ significantly ($F_{2,75} = 26.2$, $P < 0.0001$). Fig. 2 is based on data drawn from Scopus, but a similar relationship can be derived for journals not listed in Scopus by using data from Google Scholar (albeit with data of more variable quality, Bar-Ilan, 2008).

It is possible that the h-index offers a more favourable view of some disciplines, and a less favourable view of others, so it is appropriate to consider an alternative yardstick. Scopus (the database provider to ERA) offers their own measure of journal quality, the SNIP (Source Normalized Impact per Paper; Moed, 2010), which offers some independence as it was published after public submissions on the ERA ranking closed. The SNIP measures a journal's contextual citation impact, taking into account characteristics of its field, the frequency with which authors cite other papers in their reference lists, the rate of maturation of citation impact, and the extent to which a database used for the assessment covers the field's literature (Moed, 2010). The correlation between ERA category and SNIP (Fig. 3) is consistent with the pattern observed with the h-index.

Fig. 3 reaffirms the weak correlation (0.08) between the ERA ranking and other indicators of journal quality within *1203 Design* journals, and illustrates that journals with low and high SNIPs appear in all the ERA categories devised for the FOR

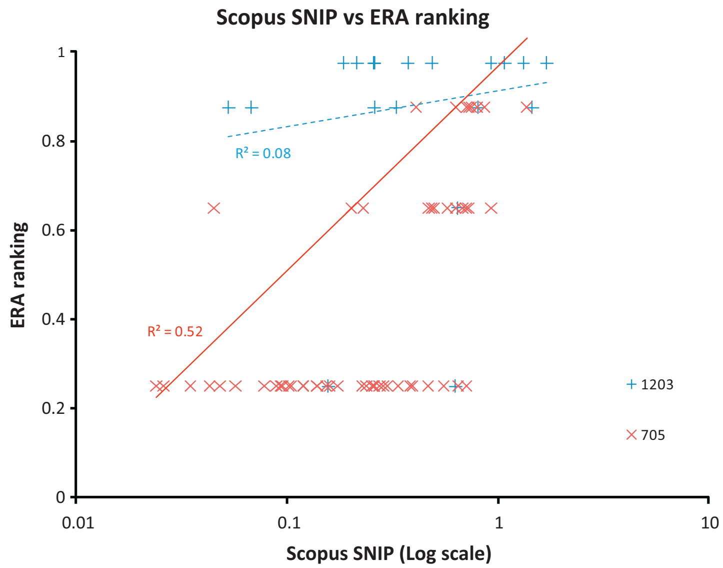

Fig. 3. Scopus SNIP (2009) versus ERA category.

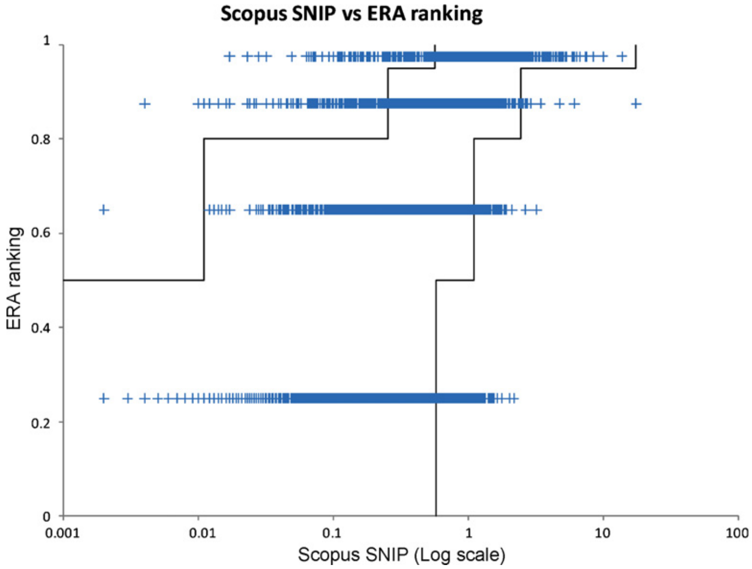

Fig. 4. Scopus SNIP (2009) versus ERA category for all Scopus-listed journals ($n = 9118$).

group *1203 Design*. Fig. 3 also reproduces the higher correlation (0.52) between the ERA ranking and the SNIP for journals within the FOR group *0705 Forestry*, and again illustrates several examples of A-ranked journals within *0705 Forestry* that have higher SNIPs than A* journals in *1203 Design*. The two trends differ significantly ($F_{2,75} = 24.8$, $P < 0.0001$).

One advantage of the h-index is that it can be computed for all journals, and is not confined to those for which Scopus has computed a SNIP. The similarity between Figs. 2 and 3 suggest that h-index offers a reasonable basis for comparisons across journals and FOR groups. There is an increasing body of evidence indicating that the h-index is a good measure of journal impact in both science and commerce (Harzing & van der Wal, 2008, 2009; Imperial & Rodríguez-Navarro, 2007; Vanclay, 2008b). However, users should be aware that Google Scholar h-indices tend to be higher, and more subject to spurious data, than h-indices derived from Scopus and Web of Science (Bar-Ilan, 2008; Meho & Rogers, 2008).

6. Comparing Scopus SNIP and journal rank across 2-digit FOR divisions

These trends observed for FOR groups *0705 Forestry* and *1203 Design* are not unique: a graph of Scopus SNIP versus ERA category for all disciplines reveals a similar lack of discrimination across categories (Fig. 4). The stepped lines in figure illustrate the bounds that would result if ranking was based solely on the SNIP within each 2-digit FOR division (i.e., the lines represent the extremes of the 50th, 80th, and 90th percentiles from each FOR division), and thus illustrates that many journals are classified in a way inconsistent with SNIP scores.

The large number of symbols in Fig. 4 makes interpretation difficult, so it is useful to examine the mean SNIP score for each ERA category (Table 7) to further evaluate these trends. Because of the non-normal distribution of these values, Table 7 reports the log-average SNIP (exponent of the average of log(SNIP)).

Overall, the average SNIP scores shown on the bottom line of Table 7 are consistent with the intention of the ERA, but this pattern is not evident within all the 2-digit FOR divisions. Ten cells in Table 7 have been shaded to illustrate departures from the expected trend. The five cells shaded light grey have higher than expected SNIP means, and the dark grey shading indicates five cells with lower than expected SNIP means. The high scores for the A* category in *02 Physical Sciences*, *06 Biological Sciences* and *07 Agricultural and Veterinary Sciences* suggests that the selection of journals was exceptionally rigorous and that inclusion of additional journals in the A* category may well be warranted. In the case of *07 Agricultural and Veterinary Sciences*, both Tables 1 and 2 suggest systematic under-representation of journals in the A* category. A* journals in the 2-digit FOR division *12 Built Environment and Design* exhibit a low average SNIP (dark grey shading), and this, coupled with the over-representation suggested in Table 1, suggests that the selection of journals for this category has been less rigorous. Similarly, the dark shading (lower than expected SNIP) for the A* category and light shading (higher than expected SNIP) for the C category suggests a less rigorous approach to the classification of journals in the 2-digit FOR divisions *19 Studies in Creative Arts and Writing*, and *21 History and Archaeology*.

7. Does it matter?

As a group, academics tend to be rational and respond to incentives and performance measures (Butler, 2003b, 2005). During the 1990s, Australian government incentives rewarded quantity not quality, and stimulated increased publication by Australian academics in lower-impact journals, without a corresponding increase in the high impact journals (Butler,

Table 7
Log-average SNIP score for each ERA category.

Discipline (2-digit FOR division)	A*	A	B	C	Average
01 Mathematical Sciences	2.0	1.2	0.9	0.5	1.0
02 Physical Sciences	3.7	1.6	0.8	0.4	0.8
03 Chemical Sciences	2.2	1.5	0.9	0.4	0.7
04 Earth Sciences	2.3	1.6	1.0	0.5	0.8
05 Environmental Sciences	2.5	1.4	1.1	0.5	0.8
06 Biological Sciences	3.1	1.6	1.0	0.5	0.8
07 Agricultural and Veterinary Sciences	**2.6**	**1.3**	**0.8**	**0.4**	**0.7**
08 Information and Computing Sciences	3.9	2.2	1.2	0.8	1.4
09 Engineering	2.4	1.7	0.9	0.4	0.9
10 Technology	2.0	1.7	0.9	0.5	0.9
11 Medical and Health Sciences	2.6	1.4	0.9	0.4	0.7
12 Built environment and design	**0.6**	**0.8**	**0.5**	**0.3**	**0.6**
13 Education	1.9	1.2	0.8	0.5	0.8
14 Economics	2.7	1.3	0.7	0.4	0.9
15 Commerce, Management, Tourism and Services	2.9	1.4	0.7	0.4	0.8
16 Studies in Human Society	1.7	1.0	0.6	0.4	0.7
17 Psychology and Cognitive Sciences	3.0	1.6	1.0	0.5	0.9
18 Law and Legal Studies	0.5	0.3	0.2	0.2	0.3
19 Studies in Creative Arts and Writing	0.6	0.3	0.2	0.3	0.4
20 Language, Communication and Culture	0.9	0.5	0.4	0.3	0.5
21 History and Archaeology	0.5	0.4	0.4	0.2	0.4
22 Philosophy and Religious Studies	0.7	0.4	0.3	0.3	0.4
MD Multidisciplinary	2.1	1.0	0.6	0.3	0.5
Average	2.0	1.2	0.8	0.4	0.7

2003b). The government announced a new Research Quality Framework (RQF) in 2005, and the journal rankings (Butler, 2008) that took shape during 2006 influenced publication patterns, refocusing the flow of publications into high-impact journals (Fig. 5). In 2007, a new government abandoned the RQF in favour of ERA, and the journal rankings released in early 2010 appear to have stimulated a renewed emphasis on publication in A*-ranked journals. Fig. 4 shows the proportion of Scopus-listed publications affiliated with one or more Australian universities and that were published in journals ranked A* by the ERA in February 2010. It is premature to attribute the kinks in this trend to the RQF in 2006 and the ERA in 2010, but the trend is suggestive of behavioural change by university academics.

Australian academics are under considerable pressure to publish in A*-ranked journals, and to achieve the threshold of 50 publications in selected FOR groups. When the ERA creates FOR groups with no A*-ranked journals, this creates a conflict for academics. This conflict may have real and serious practical consequences. For instance, Scopus data reveals that Australian academics contribute about 5% of the papers categorized as *0705 Forestry* worldwide. In selected fields, for instance research concerning the genus *Eucalyptus*, Australian academics have an even higher impact, contributing 40% of all B- and C-ranked publications, and 60% of A-ranked publications worldwide (in journals categorised *0705 Forestry*). Closer to home, Australian academics contribute about half the articles published in the national C-ranked journal *Australian Forestry* that received by all members of the professional Institute of Foresters of Australia. The professionalism of forestry in Australia, and the viability of this journal, may be threatened if Australian academics are motivated to divert their contributions elsewhere. Science will suffer if the effort to improve research excellence in Australia motivates Australian researchers to publish their work

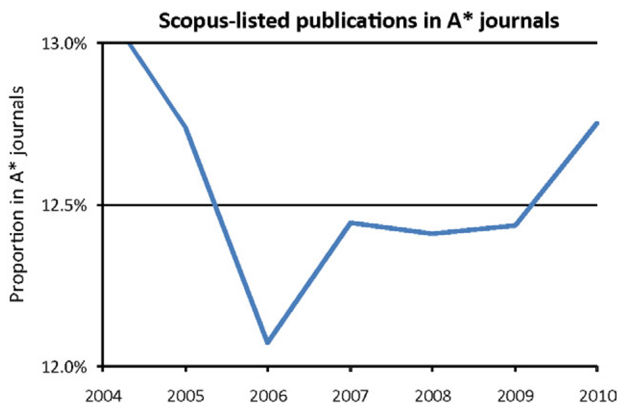

Fig. 5. Scopus-listed journal articles published by Australian academics.

Table 8
Errata and retractions published in Scopus-listed journals 2003–08.

Class of journal (Scopus)	Total papers	Errata and retractions	
		Papers	%
Nature and Science	29,659	739	2.5
Multidisciplinary	98,766	1307	1.3
Environmental & Agriculture	1,107,472	6029	0.5
Forestry (ERA FOR group 0705)	20,086	137	0.7

in generic A*-ranked multidisciplinary journals instead of in disciplinary journals that constitute the mainstream of their science.

There is some evidence that scientific contributions are best reviewed within their own discipline, where reviews may be the most stringent. Issues such as the Schön affair (Beasley, Datta, Kogelnik, Kroemer, & Monroe, 2002) beg the question whether prominent journals such as *Nature* and *Science* are more prone to inadequate review. The incidence of errata and retractions in these journals is higher than in disciplinary journals (Table 8): this is not necessarily indicative of inadequate reviewing, and may also reflect a stringent approach to errors and retractions. However, Table 8 does lend support the notion that within-discipline publication is rigorous, and thus that the ERA should provide A* journals within each 4-digit FOR group.

8. Conclusion

This paper has attempted to test a series of hypotheses regarding the ERA initiative. It has examined the assumption that the ERA journal classification is fair and equitable across all disciplines (rejected, $\chi^2_{69} = 547$, $P < 0.0001$), that the FOR group 0705 Forestry has been treated fairly and equitably (rejected, Fisher's exact test, $P = 0.023$), that all the A*-ranked journals in 1203 are of equally high standing (rejected, over half of the A* journals have none of the most-cited papers), and that the ERA classification for both *0705 Forestry* and *1203 Design* exhibit comparable trends with other measures such as h-index and SNIP (rejected, trends differ, $F_{2,75} = 24.8$, $P < 0.0001$).

It appears that the present ERA classification lacks sufficient rigour in terms of the relative numbers of journals in each category, and in terms of other independent indicators of quality (such as h-index and SNIP). These discrepancies detract from the credibility and impartiality of the ERA classification, and further revision appears warranted. These limitations of the ERA are likely to have a detrimental effect in disciplines that lack sufficient journals ranked as A*.

ERA should re-examine the distribution of journals within and between each FOR group; should consider the merits of replacing the four quality categories with a continuum defined by a metric such as SNIP or h-index; and should consider abandoning a journal-based approach in favour of an article-based approach (e.g., citations accruing to each paper, possibly weighted cf. PageRank, Brin & Page, 1998). Either alternative would be preferable to the current categorical approach, because it would align authors, publishers and institutions in fostering public access to, and uptake of research. Such revision is important and urgent, because the current ERA is likely to be detrimental to several scientific disciplines.

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