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Gauging the impact of journals

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Many stakeholders, including authors, editors, librarians and funding agencies, have an interest in reliable assessments of journal impact, but the provision of this service has long been dominated by a single service, the Journal Impact Factor (JIF; Garfield, 1955) provided by the ISI and Thomson Scientific. Despite several limitations (Hecht et al., 1998; Moed et al., 1999; van Leeuwen et al., 1999; Saha et al., 2003; Dong et al., 2005; Moed, 2005; Dellavalle et al., 2007), the JIF continues to be the dominant indicator of journal performance. Recently, Hirsch's *h*-index (Hirsch, 2005; Bornmann & Daniel, 2007) has been suggested as an alternative that is reliable, robust and easily computed (Braun et al., 2006; Chapron and Husté, 2006; van Raan, 2006; Rousseau, 2007; Schubert and Glänzel, 2007; Vanclay, 2007). The *h*-index has been used to rank researchers (Oppenheim, 2006) and institutions (Bose, 2006; Grant et al. 2007), and offers some interesting insights into the relative ranking of forestry literature (Vanclay 2008).

Vanclay (2008) examined rankings of forestry journals commissioned by the Australian Academy of Technological Sciences and Engineering in preparation for the (now defunct) Australian Research Quality Framework, and contrasted these with objective metrics including *h*-indices computed from two sources, the Web of Science (Thomson Scientific, version 4.0, WoS) and Harzing's (2007) Publish or Perish (PoP), a software package that harvests data from Google Scholar. Hirsch's h-indices were computed for several intervals, but the 8-year interval 2000-2007 seemed insightful for forestry journals, many of which have a long cited half-life. The *h*-indices computed from WoS and PoP are similar ($r = 0.93$, $n = 43$ for 2000-2007 data), but the

former are available only for WoS-listed journals, whereas the latter can be computed for any journal or source visible to Google Scholar.

Although the *h*-index (2000-2007) is well correlated with the JIF (Figure 2; r=0.88 for PoP data, r=0.91 for WoS data), it exhibited closer agreement with the expert assessment (r=0.62) than did the JIF (r=0.56), suggesting that the *h*-index may be useful for ranking journals objectively. A further advantage of the *h*-index is that it may be computed for the many journals not acknowledged by the Thomson Scientific.

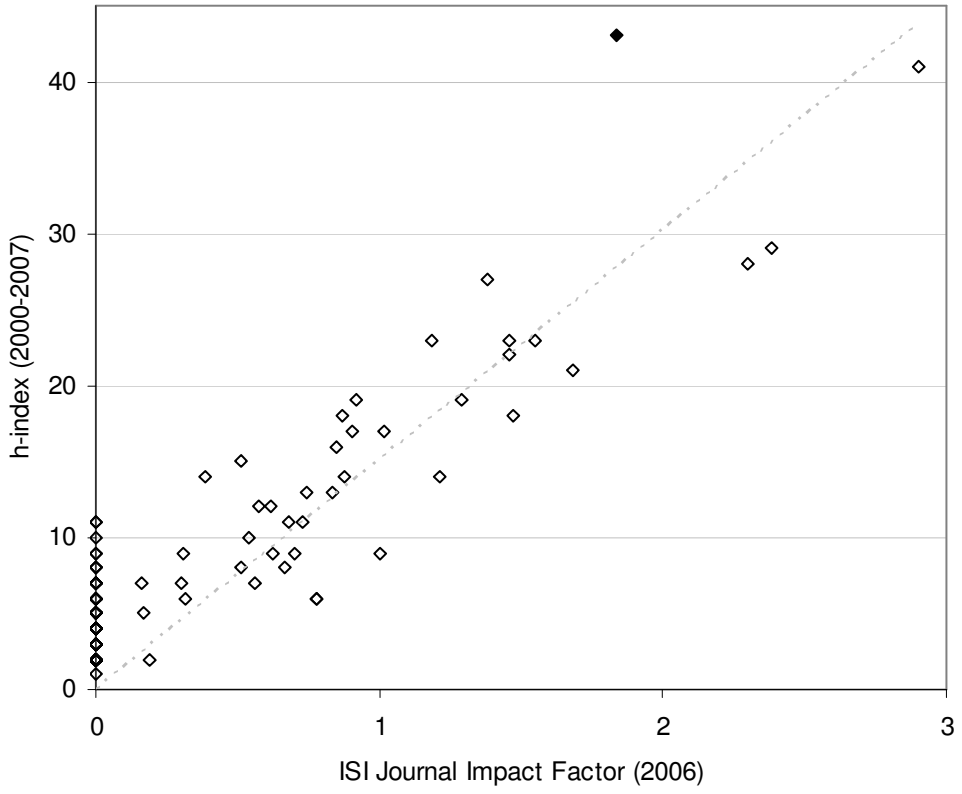

Figure 1. The relationship between the JIF and the PoP *h*-index (based on all citations accruing to journal publications during 2000-2007). The filled point near the top centre of the figure is *Forest Ecology and Management; Agricultural and Forest Meteorology* is at the top right. Journals not recognised by Thomson Scientific are shown with a zero JIF, and are omitted from the calculation of the trend line (trend based on 43 journals).

Expert ranking of two journals, *Agricultural and Forest Meteorology* (AFM) and *Forest Ecology and Management* (FEM), differed greatly to that implied by the JIF. The former has a higher JIF, but experts ranked the latter as more influential, as did the *h*-index (Figure 1). Table 1 lists some key differences between these journals: AFM has a relatively small number of contributions, many of which are cited soon after publication, whereas FEM has a higher volume and is slower to accrue citations. Overall, the *h*-indices of the journals are comparable, but there is a tendency for WoS to report higher statistics for AFM, and for PoP to report higher statistics for FEM. Superficial examination of Table 1 may lead to the suggestion that AFM publishes relatively few papers all of which are high-quality, reflecting a high editorial standard, and in turn, credit to any author who has a paper accepted for publication. However, this interpretation is simplistic, and warrants closer examination.

Table 1. Statistics for two leading forestry journals.

Indicator	*Agricultural and Forest Meteorology*	*Forest Ecology and Management*
JIF (2006)	2.903	1.839
Immediacy	0.669	0.356
Cited half-life	6.7	5.8
Total articles	130	601
Lifetime *h*-index (WoS)	60	58
h-index 2005-6	12	12
JIF (2006)	2.903	1.839
h-index 2000-7 †	43	36
Total cites 2000-7 †	9 113	21 470
Lifetime *h*-index (PoP)	67	69
h-index 2005-6	9	12
Mean cites/paper 2005-6	2.09	1.67
h-index 2000-7 †	41	43
Total cites 2000-7 †	8 544	25 913

† computed 5 December 2007.

Table 2 examines selected citation performance of these two journals, year-by-year for the last decade, and tabulates the proportion of papers in each journal that remain uncited (Weale et al., 2004), or fail to accrue at least one citation per year since publication. Despite its lower JIF, FEM has a lower proportion of papers that remain uncited, or that remain infrequently cited, for almost every year during the past decade, suggesting that by these yardsticks, FEM may be the journal that reflects better on contributors. This conclusion from Table 2 is reflected in the *h*-index, but not in the JIF (Table 1). Table 2 also illustrates that the *h*-index appears to plateau after eight years (i.e., in 2000), at least for these two forestry journals.

Table 2. Annualised data for two forestry journals.

	Agricultural and Forest Meteorology				*Forest Ecology and Management*			
Year	*h*-index (WoS)	*h*-index (PoP)	Fraction uncited (annualized %)	Not cited >1/year (%)	*h*-index (WoS)	*h*-index (PoP)	Fraction uncited (annualized %)	Not cited >1/year (%)
2007	3				2			
2006	6	4	49	49	7	6	62	62
2005	12	9	45	39	12	13	46	38
2004	18	15	54	35	16	18	47	34
2003	19	17	65	48	21	24	53	33
2002	20	17	71	45	26	29	55	33
2001	22	20	67	42	24	30	64	38
2000	24	27	71	39	30	35	64	38
1999	24	25	65	34	28	34	71	40
1998	21	23	70	35	31	34	73	44
Mean			62	41			59	40

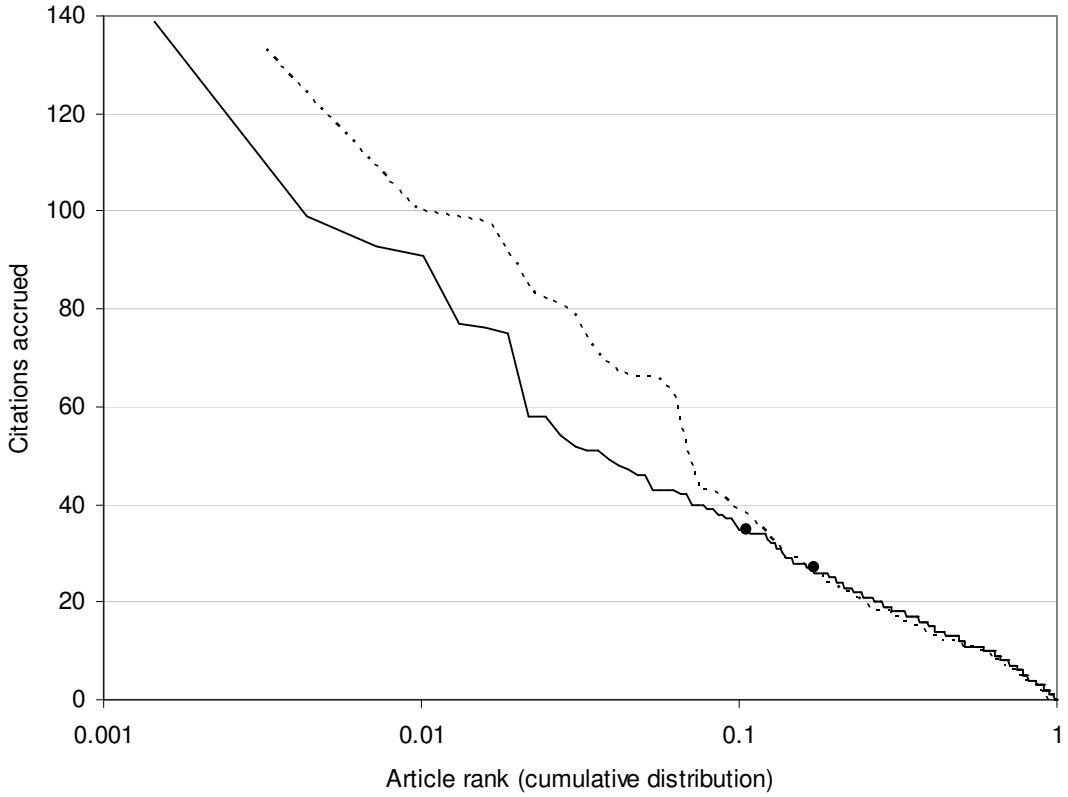

Figure 2. Pattern of citation accrual to two journals, *Agricultural and Forest Meteorology* (dotted) and *Forest Ecology and Management* (solid), using data from PoP. Note that the log-linear trend in the right-most part of the figure includes the point indicating the *h*-index (•).

Figure 2 illustrates the trends in citations to individual papers published in these two journals during the year 2000. The publication year 2000 was chosen because it reflects the half-life of these journals, and allows citation patterns to be fully expressed (Table 2; also Vanclay, 2008, 2009). Figure 2 reveals the number of citations for each paper in rank order, scaled to reflect the cumulative distribution function because of a three-fold difference in the number of papers published in these two journals. A logarithm scale is used because the great majority of papers accrue few citations, and exhibit a log-linear trend in their citation rate. Figure 2 shows that the two journals have a very similar pattern of citation accrual to the majority of contributions, and

that it is only in the most-frequently-cited 10% of papers that differences in citations appear. This equivalence is reflected in the *h*-indices (27 for AFM, 35 for FEM, PoP data), but not in the JIFs of the two journals (Table 1), which create the impression that AFM is a substantially better journal than FEM.

The log-linear trend in citation accrual (Figure 2) appears generic, applies to many journals, and is neatly summarised by the *h*-index, since it reflects the gradient of this relationship. Fewer than *h* papers (where *h* is the *h*-index) depart from this trend (i.e., those at the top left of Fig. 3), and appear to reflect 'popularity', rather than research quality *per se*. The pattern revealed in Figure 2 leads to the suggestion that a classification of journals based on the *h*-index may provide a better indicator than the JIF. Figure 2 implies that the median journal contribution will be cited about *h*/3 times, an estimate that (unlike the JIF) is unaffected by the few papers that are frequently cited. A further advantage is that it can be calculated quickly and easily (e.g., with the PoP software; Harzing, 2007) for all journals, including those not recognised by Thomson Scientific. Figure 1 includes 43 journals recognised by Thomson Scientific, but also includes 43 journals with $h \geq 4$ not recognised by Thomson Scientific and without a JIF.

Tables 1 and 2, and Figure 2 suggest that AFM and FEM are similar in many regards, but Figure 1 highlights the large discrepancy between the JIF and the *h*-index for these two journals. The total number of citations reported in Table 1 may shed some light on this difference. AFM appears to service a specialised audience that is more visible to Thomson Scientific than to Google Scholar. In contrast, FEM is cited in a substantial number of non-academic publications visible to Google Scholar, which reports 20% more citations than WoS (Table 1, Vanclay 2008). The difference in ratio of PoP:WoS h-indices (0.94 for AFM and 1.2 for FEM) seems to suggest that AFM is cited mainly by (and hence likely to be used mainly by) researchers, while the higher ratio for FEM may indicate greater uptake by practitioners.

There is no doubt that an *h*-index based on Google Scholar is imperfect, in part because it can be manipulated with bogus documents on personal websites, and may be inflated by provocative contributions. However, the JIF is also imperfect, because it is available only for journals selected by Thomson Scientific, and because of limitations in the calculation of the JIF (Jacso, 2001; Dong et al., 2005; Vanclay, 2009).

Table 3. Ranked list of the top ten forestry journals.

Journal Title	**JIF**	***h*-index 2000-7**
Forest Ecology and Management	1.839	43
Agricultural and Forest Meteorology	2.903	41
Journal of Vegetation Science	2.382	29
Tree Physiology	2.297	28
*Plant Ecology (*formerly *Vegetatio)*	1.383	27
Canadian Journal of Forest Research	1.549	23
Forest Science	1.457	23
Journal of Forestry	1.188	23
Trees Structure and Function	1.461	22
International Journal of Wildland Fire	1.679	21

Table 3 offers a list of the top ten (or approximately 5% of) forestry journals (Vanclay 2008). The JIF is available for these journals, but these are the exception. Google Scholar makes it easy to identify and rank journal impact, and to judge objectively whether or not a journal is generalist or devoted to discipline. Because of its broader coverage, Hirsch's *h*-index based on Google Scholar data may be more useful than the Journal Impact Factor, as a measure of journal quality, and in providing a basis to rank journals.

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