

Scientific numerology

Understanding and navigating research metrics

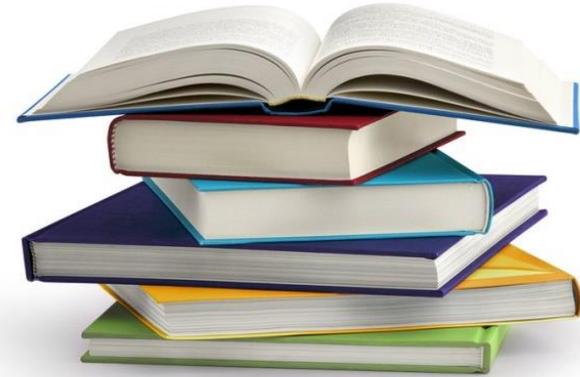


Russell Bonduriansky

What is 'research impact'?



Metrics
(*h*-index, citations, SciVal, JIF, etc)



Short-term
(~5 years)

Long-term
(~20+ years)



Goodhart's Law

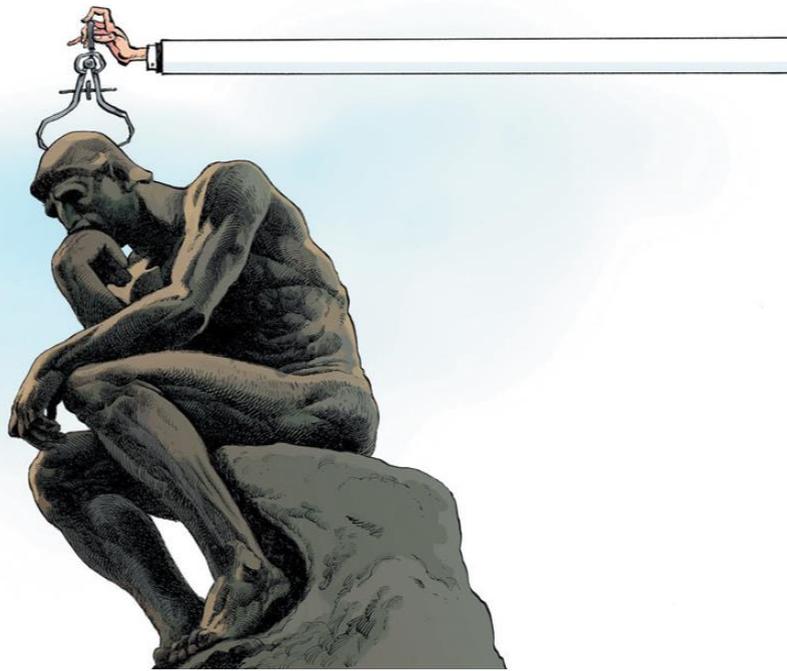
- **Goodhart's law** is an adage named after economist Charles Goodhart, which has been phrased by Marilyn Strathern as: "When a measure becomes a target, it ceases to be a good measure." (Wikipedia)



Marilyn Strathern



Charles Goodhart



The Leiden Manifesto for research metrics

Use these ten principles to guide research evaluation, urge **Diana Hicks**,
Paul Wouters and colleagues.

- Quantitative evaluation should support qualitative, expert assessment
- Base assessment of individual researchers on a qualitative judgement of their portfolio
- Recognize the systemic effects of assessment and indicators
- etc

Common metrics in academic CVs, applications, etc:

- total number of publications
- total number of citations
- *h*-index
- SciVal
- Journal Impact Factor (JIF)



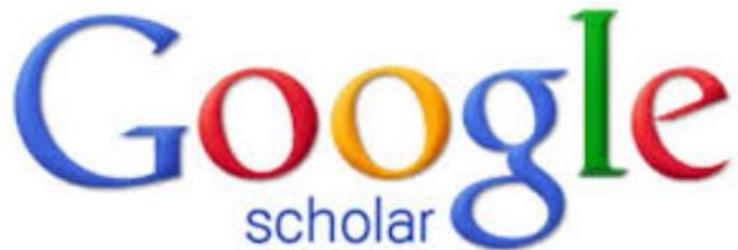
Common metrics in academic CVs, applications, etc:

- total number of publications → lead author? high-quality papers?
- total number of citations → lead author?
- *h*-index → lead author?
- SciVal → ???
- Journal Impact Factor (JIF) → lead author? high-quality papers?



Online publication lists

- Google Scholar profiles provide a very quick and useful way to find a researcher's publication list and most important work



Google Scholar vs. Scopus vs. ISI

- **Google Scholar** indexes all “scholarly publications” including journal articles (in all languages), edited book chapters, scholarly books, and theses
- **Scopus** indexes journal articles (only some journals, and mostly in English), and some edited book chapters
- **ISI Web of Science** indexes journal articles only (only some journals, and mostly in English)

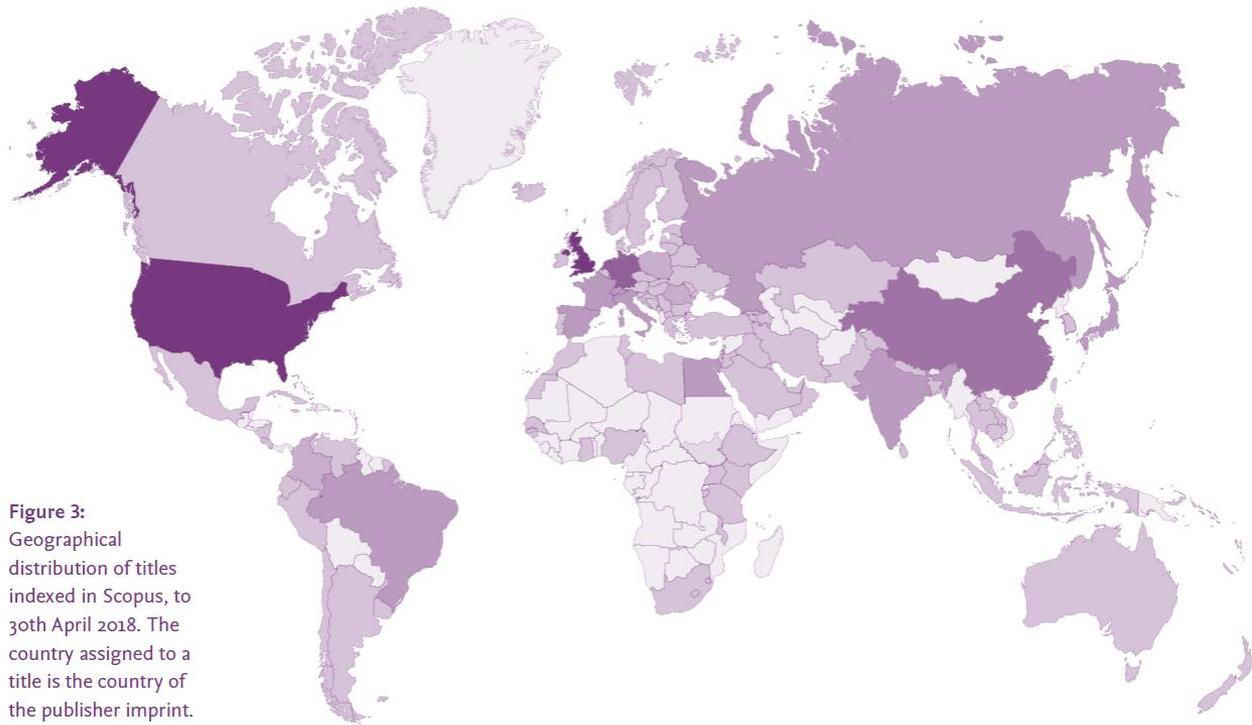


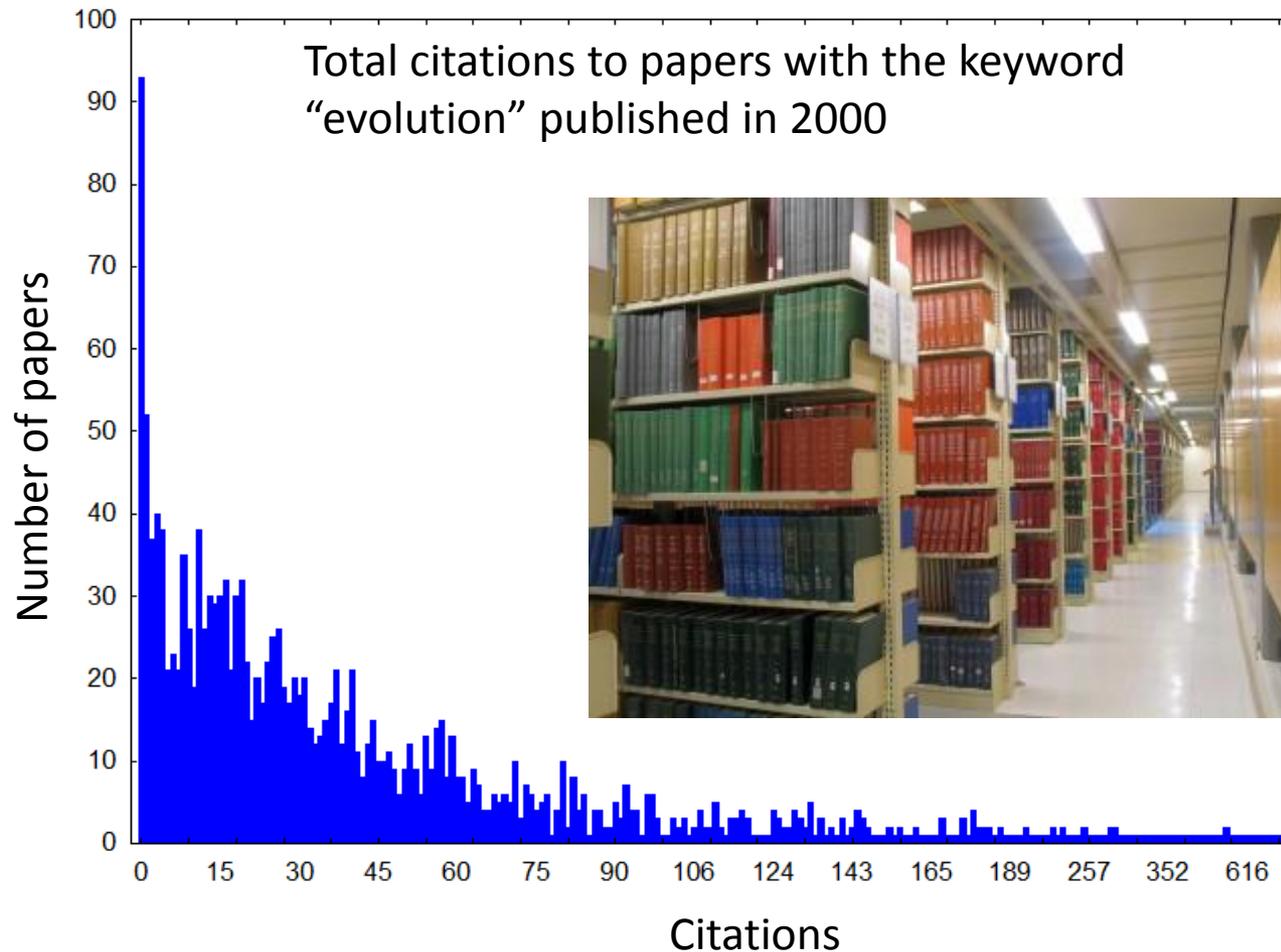
Figure 3:
Geographical
distribution of titles
indexed in Scopus, to
30th April 2018. The
country assigned to a
title is the country of
the publisher imprint.

The sliding scale indicates the density of indexed titles.



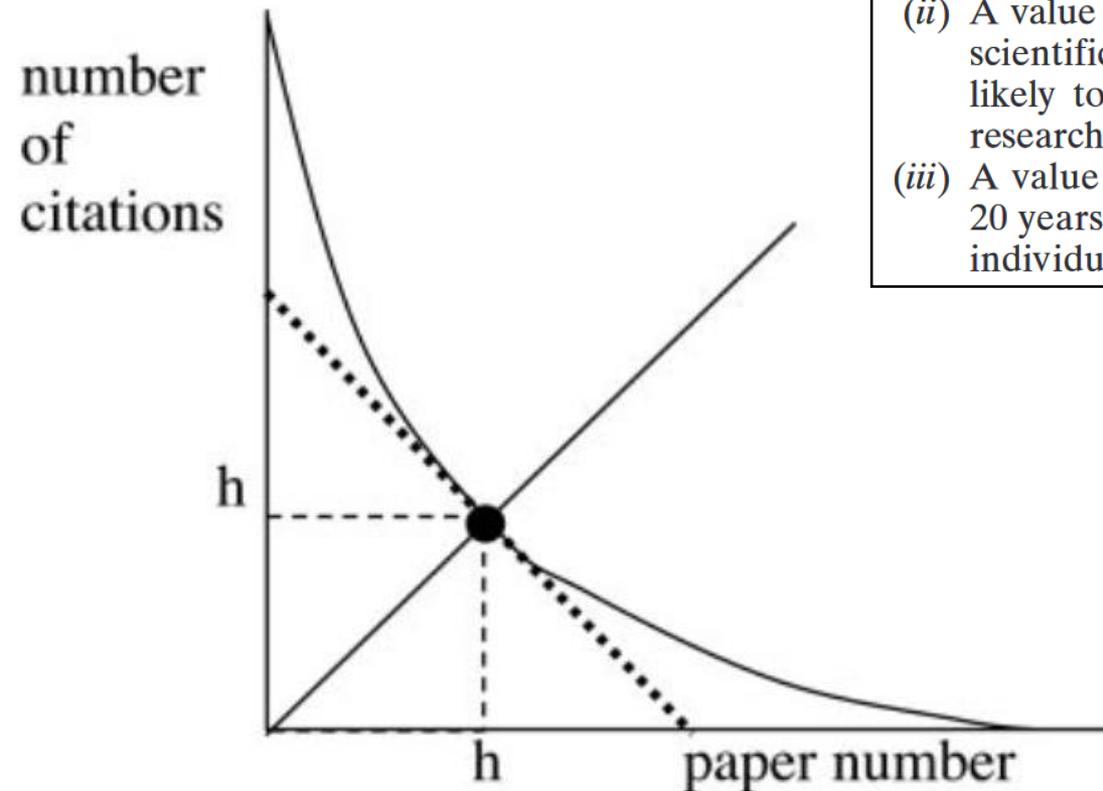
Quality vs. quantity

- Number of papers published is often regarded as research productivity
- Number of citations (total or per paper) is often regarded as research quality/impact
- **Quality is more important than quantity!**



h-index

- A scholar with an index of h has published h papers each of which has been cited in other papers at least h times
- h increases with career length
- The m -index is the h -index divided by the number of years publishing



- (i) A value of $m \approx 1$ (i.e., an h index of 20 after 20 years of scientific activity), characterizes a successful scientist.
- (ii) A value of $m \approx 2$ (i.e., an h index of 40 after 20 years of scientific activity), characterizes outstanding scientists, likely to be found only at the top universities or major research laboratories.
- (iii) A value of $m \approx 3$ or higher (i.e., an h index of 60 after 20 years, or 90 after 30 years), characterizes truly unique individuals.



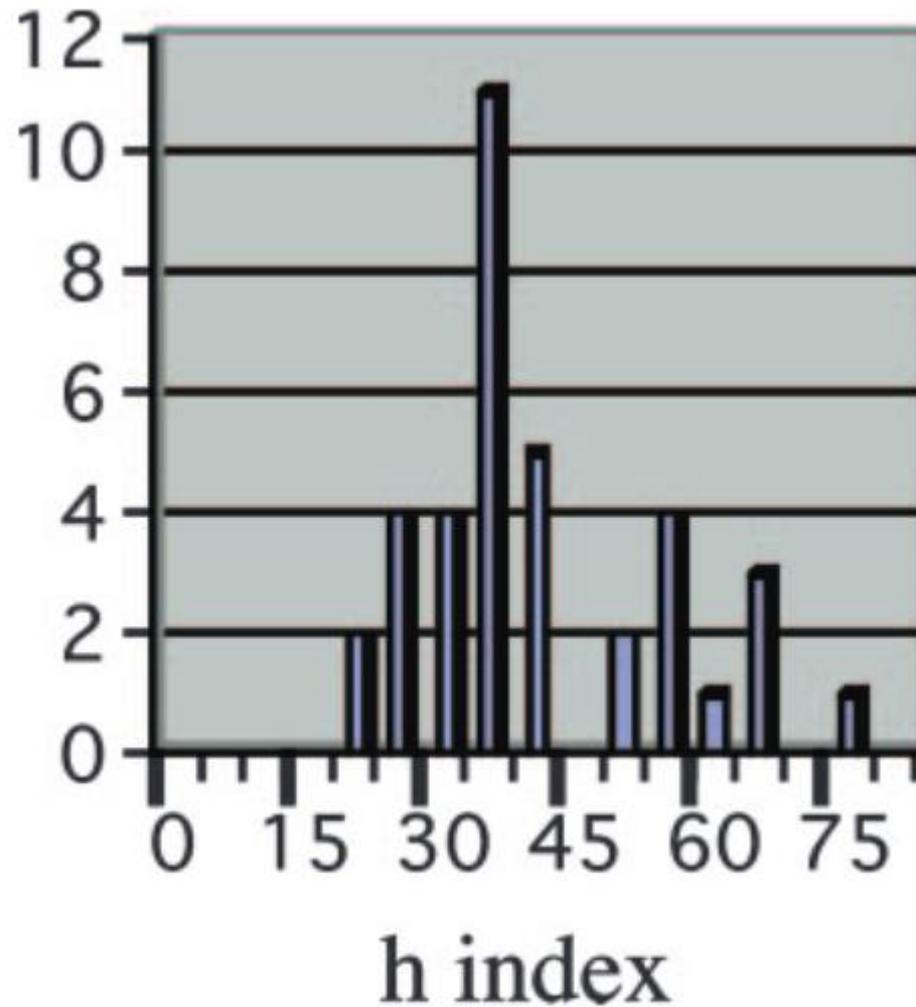


Fig. 2. Histogram giving the number of Nobel prize recipients in physics in the last 20 years versus their h index. The peak is at the h index between 35 and 39.

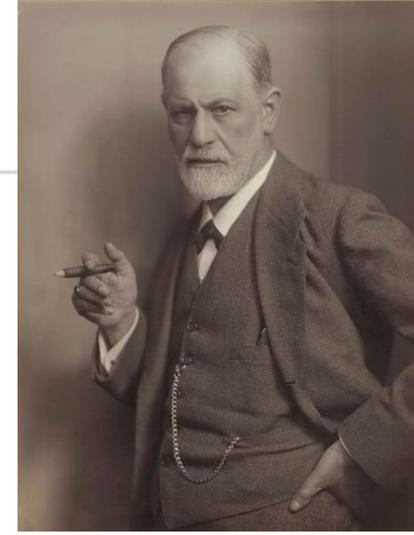


Table 1. World Ranking of top of 20 Highly Cited Researchers ($h > 100$).

RANK	NAME	INSTITUTION	H-INDEX
1	Sigmund Freud	University of Vienna	251
2	Graham Colditz	Washington University in St. Louis	249
3	Eugene Braunwald	Brigham and Women's Hospital; Harvard Medical School	232
4	Michel Foucault	Collège de France	218
5	Ronald C Kessler	Harvard University	214
6	Pierre Bourdieu	Centre de Sociologie Européenne; Collège de France	210
7	Robert Langer	Massachusetts Institute of Technology MIT	209
8	Richard A Flavell	Yale University	197
9	Gordon Guyatt	McMaster University	192
10	Eric Topol	Scripps Research Institute	191
11	Peter Barnes	Imperial College London	187
12	T W Robbins	University of Cambridge	187
13	Michael Graetzel	Ecole Polytechnique Fédérale de Lausanne	185
14	A S Fauci	National Institutes of Health NIH	185

Table 4. The *Scimago* World ranking of top 50 countries according to h-index in year 2014.

	Country	Documents	Citable documents	Citations	Self-Citations	Citations per Document	H index
1	 United States	552.690	494.790	352.934	194.831	0,64	1.648
2	 United Kingdom	160.935	141.425	111.107	36.592	0,69	1.015
3	 Germany	149.595	136.516	98.852	35.407	0,66	887
4	 France	104.739	96.467	64.942	19.988	0,62	811
5	 Canada	88.117	80.051	57.605	15.595	0,65	794
6	 Japan	114.999	107.171	51.447	18.208	0,45	745
7	 Italy	93.064	84.016	60.766	22.284	0,65	713
8	 Netherlands	50.732	45.774	40.745	10.248	0,80	694
9	 Switzerland	38.308	34.924	33.322	7.719	0,87	686
10	 Australia	77.880	70.579	52.104	16.939	0,67	644
11	 Sweden	33.847	31.076	24.987	5.722	0,74	614
12	 Spain	78.817	71.795	47.018	14.359	0,60	591
13	 Belgium	28.679	26.232	21.895	4.969	0,76	547
14	 Denmark	22.187	20.292	19.412	4.672	0,87	518
15	 Israel	17.388	15.836	11.577	2.453	0,67	496
16	 China	452.877	438.601	152.140	95.472	0,34	495
17	 Austria	21.117	19.102	14.825	3.292	0,70	449
18	 Finland	17.203	15.936	11.606	2.851	0,67	443
19	 South Korea	72.269	68.140	30.859	9.608	0,43	424
20	 Norway	17.767	15.800	11.291	2.978	0,64	402
21	 Russian Federation	50.430	49.018	15.155	6.892	0,30	390
22	 India	114.449	106.078	34.961	15.607	0,31	383
23	 Brazil	59.736	56.368	18.521	6.654	0,31	379

The h -index rewards a particular *distribution* of cites

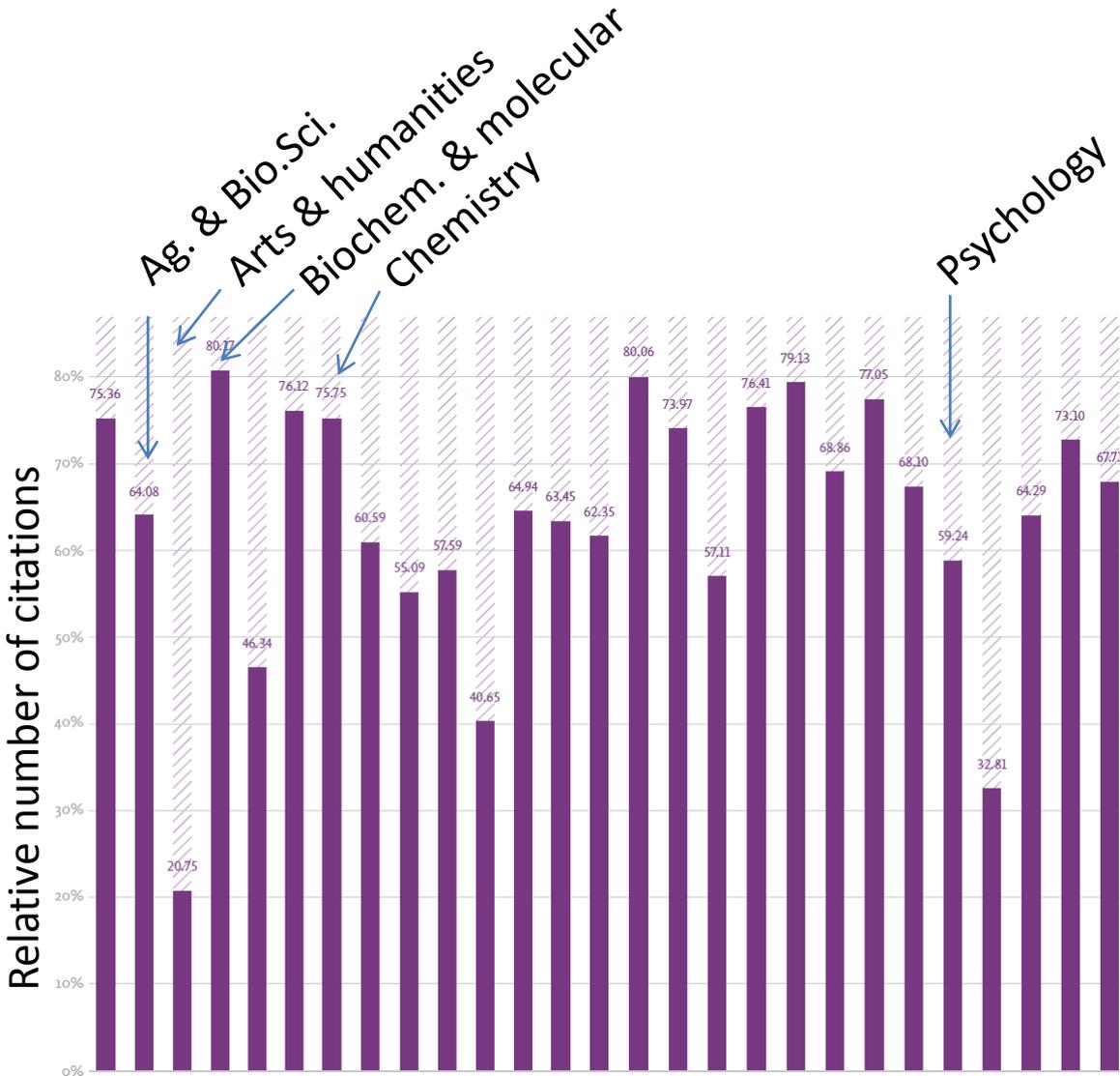
10 papers cited 10 times each:
100 citations, $h = 10$

1 paper cited 100 times:
100 citations, $h = 1$

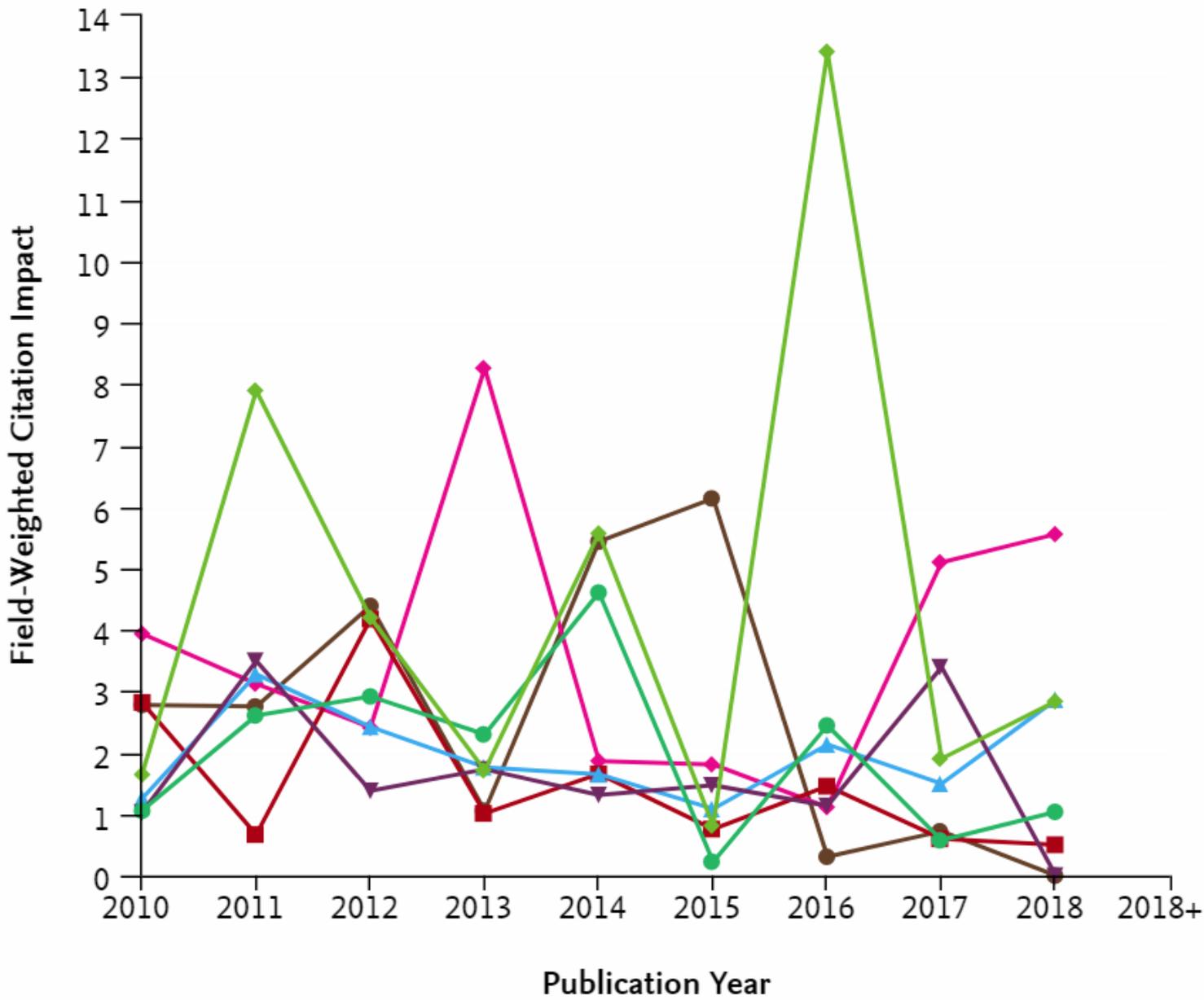
Which of these is better science???

SciVal and Field-Weighted Citation Impact

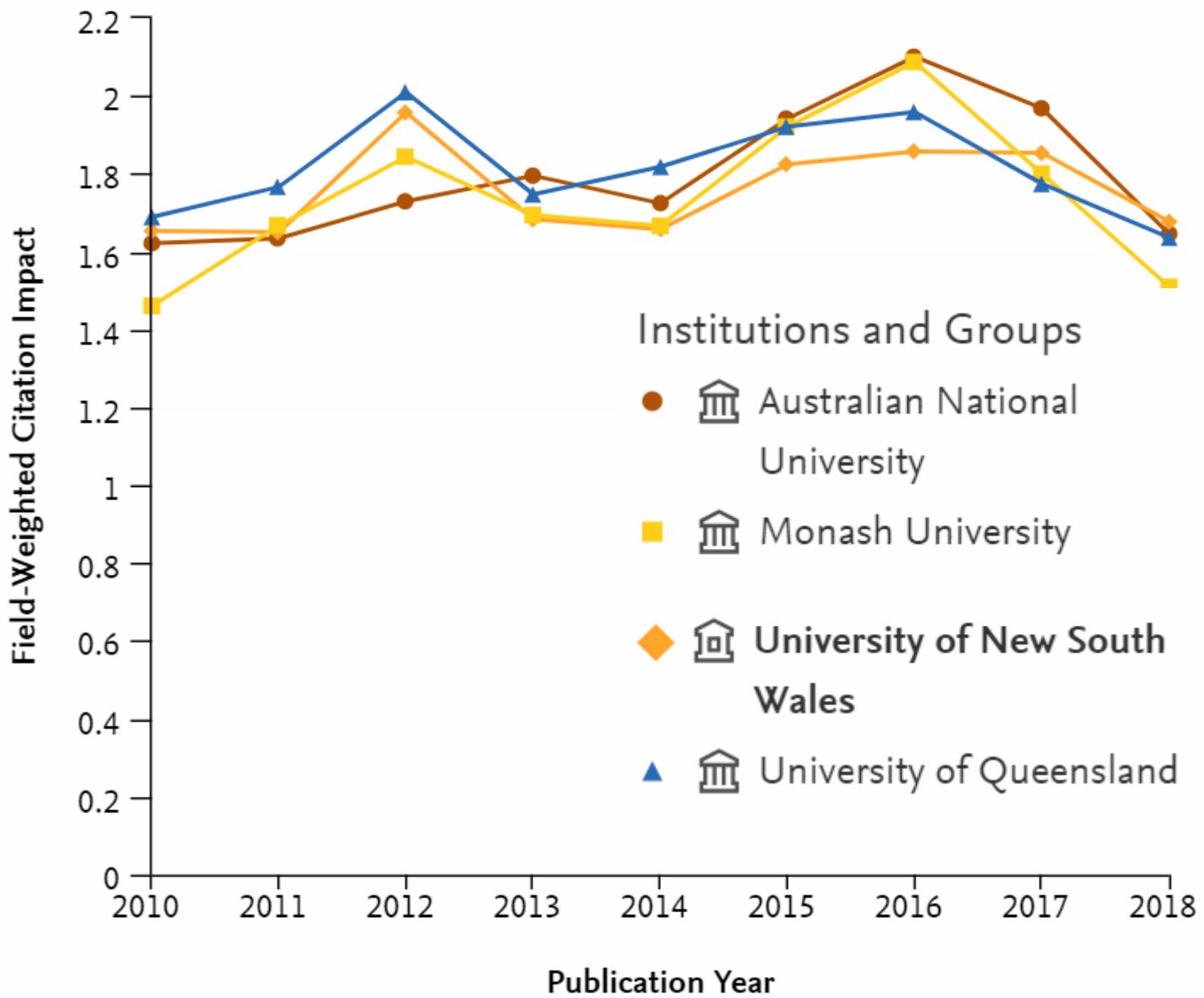
- SciVal is a Scopus (Elsevier) database that calculates the Field-weighted Citation Impact (FWCI), a metric designed to correct for differences among disciplines in citation rate
- The FWCI is not useful for comparing individual researchers
- UNSW's administration loves it!



Individual FWCI's for some senior BEES ecologists



Mean FWCI's for selected Australian universities



Journal Impact Factors

- The JIF (from “Journal Citation Reports,” ISI Web of Knowledge) is a metric of “journal impact”
- For a given journal, it’s calculated as the number of citations in year t to papers published in years $t-1$ and $t-2$

Ecology journals ranked by JIF

Compare Selected Journals		Add Journals to New or Existing List		Customize Indicators	
Select All		Full Journal Title	Total Cites	Journal Impact Factor ▼	Eigenfactor Score
<input type="checkbox"/>	1	TRENDS IN ECOLOGY & EVOLUTION	35,124	15.938	0.03882
<input type="checkbox"/>	2	Annual Review of Ecology Evolution and Systematics	19,458	10.160	0.01098
<input type="checkbox"/>	3	ISME Journal	19,791	9.520	0.05672
<input type="checkbox"/>	4	ECOLOGY LETTERS	30,928	9.137	0.05119
<input type="checkbox"/>	5	GLOBAL CHANGE BIOLOGY	36,182	8.997	0.07242
<input type="checkbox"/>	6	FRONTIERS IN ECOLOGY AND THE ENVIRONMENT	9,137	8.302	0.01625
<input type="checkbox"/>	7	ECOLOGICAL MONOGRAPHS	10,569	7.828	0.00734
<input type="checkbox"/>	8	Molecular Ecology Resources	9,272	7.059	0.01739
<input type="checkbox"/>	9	Methods in Ecology and Evolution	8,866	6.363	0.03704

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ISO: Am. Nat.

JCR Abbrev: AM NAT

LANGUAGES

English

CATEGORIES

ECOLOGY - SCIE

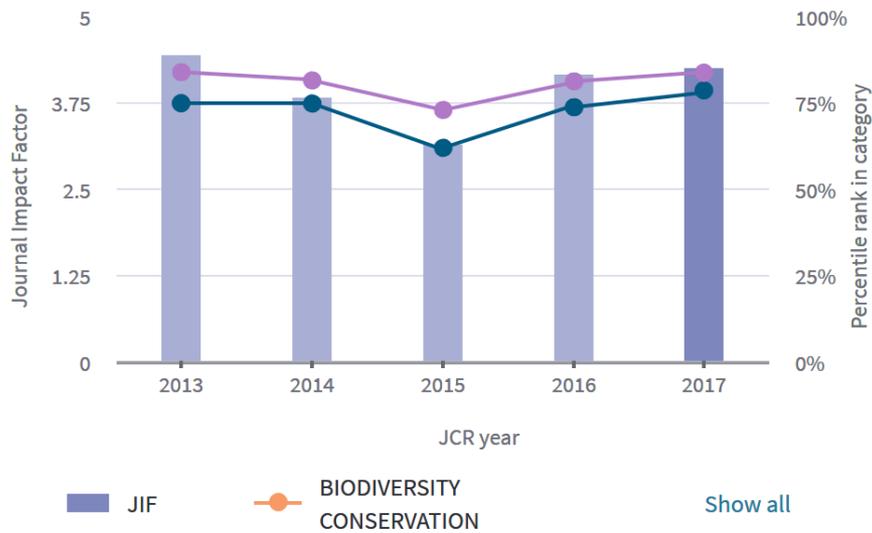
PUBLICATION FREQUENCY

12 issues/year

Journal Impact Factor Trend 2017

4.265

2017 Journal Impact Factor



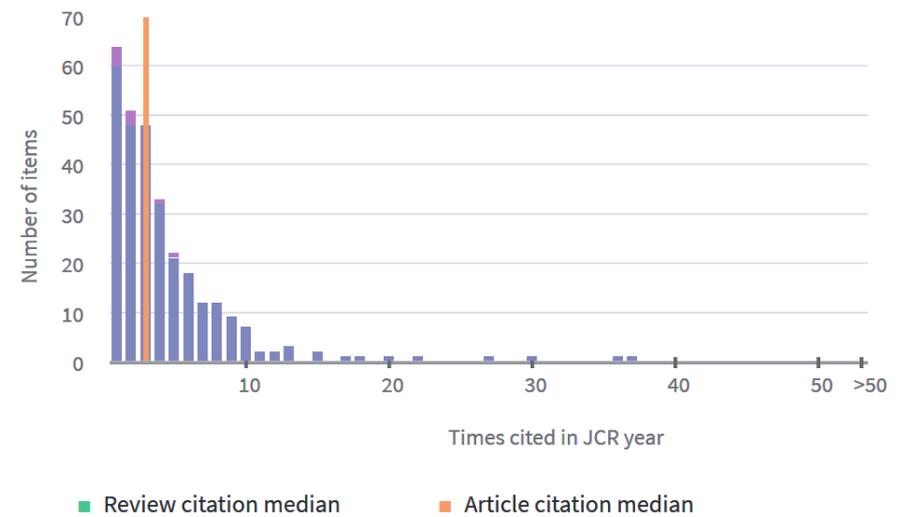
Citation distribution

3

Article citation median

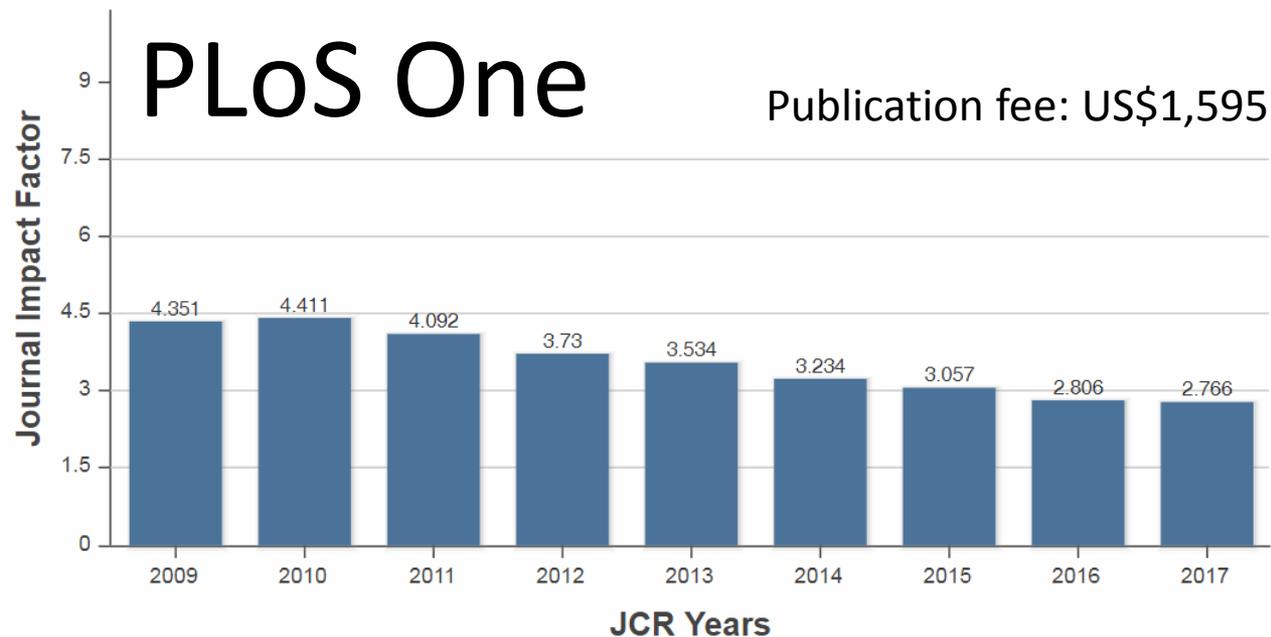
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Review citation median



Should you use JIF to choose where to publish?

- Journals with higher JIF might look better on your CV because these journals can be hard to get into, but...
- Journals have a reputation independent of their JIF
- Journals target different audiences (hint: look at the Editorial Board)
- Publication costs can vary substantially
- Some journals are published by scientific societies, others are money-making operations



My advice:

- Take metrics with a big grain of salt
- Always go for quality over quantity
- Create a Google Scholar profile for yourself so people can easily find your work
- Don't rely solely on JIF when choosing where to submit your papers: put more emphasis on journal audience and reputation

