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Characterizing author citation ratings of herpetologists using Harzing's Publish or Perish

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Abstract. Evaluation of scientists according to their publication counts and the impact ratings of the journals in which they publish is growing in popularity. However, if a scientist is to be rated, it is more logical to assess the citations to its own work. This is especially true considering that fewer than half of the papers published in journals account for over half of the citations to those journals. Therefore, relatively few papers in highly rated journals are actually highly cited. There are numerous metrics used to compare authors based on their citation rates. In this study, I analyzed a random sample of herpetologists appearing on the 2004 membership list of the *Societas Europaea Herpetologica*. I used linear regression to analyze the influence of career length and publication count on their h-score, g-score, e-score, and m-quotient. I also examined how publication count changes during the career of the average herpetologist. I verified that the h-score increases as career length of a herpetologist gets longer, but I found that the h-scores also become more variable among herpetologists with lengthy careers. The g-score followed the same pattern as the h-score, but the disparity between the h-score and g-score became wider as some papers accumulated more citations than others. The e-score reinforced the belief that h-index scores are more variable among late career herpetologists than early career herpetologists. The m-quotient remained relatively stable throughout a herpetologist's career because it is intended to control for career length. Thus, this metric can be used to compare early and late career herpetologists. Herein, I provide mean scores for each author metric for herpetologists at various career lengths. Hopefully, the data and relationships presented will be useful tools for investigators seeking to understand their development as a herpetologist and for those individuals interested in assessing a herpetologist's performance relative to others in this field.

Keywords. Citation rating, impact rating, herpetology, herpetologists

Introduction

The problem of measuring scientific productivity is a dilemma for scientists and administrators alike. Many scientists aspire to publish in the highest rated journals (Lawrence 2003). The push to publish in the highest rated journals may cause some important areas of research to be ignored (McCallum and McCallum 2006), and, some believe that this movement is degrading or even corrupting the scientific process (Lawrence 2003). There are several alternatives to monitoring the impact ratings of journals in which scientists publish. One can examine the author publication statistics of a scientist to determine if this individual is within the expected range for an academic field such as herpetology. There are several author statistics available for evaluating scientific productivity that encompass the number of published articles by an author and the overall citation rate to an author's portfolio.

The most obvious of these is the number of articles the individual publishes during his/her career. However, there is much controversy associated with this statistic not the least of all is how to compare two authors, one with 10 monographs and the other with 10 peer reviewed notes (Fox 1983, Liu 1993). Clearly, these are not equivalent levels of productivity. At the same time, if the 10 monographs are virtually ignored and one of the short publications revolutionizes our understanding as did the description of DNA (Watson and Crick 1953), which is more important? Fortunately, there are additional author statistics available for evaluating productivity. Unfortunately, none of these is perfect and none is intended to stand alone but instead in light of the others .

Many author metrics are referred to as author citation indexes because they evaluate the citations to an individual's papers, hence a direct indication of the recent interest in an investigator's work (Hirsch 2005), and speculatively its impact on the field (Diamon 1986, Moed 2005). Evaluating journal citation ratings is an indirect method that inaccurately assumes that all papers in highly rated journals are highly cited. In fact, this is seldom the case. Articles in the most cited half of those published in a given journal are cited ten times more often than those in the least cited half and many go uncited (Seglen 1997). Further, journal impact factor is

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a poor predictor of article citation rates (Seglen 2000). In fact, it is the article citation rates that determine the Journal impact factor (Saha et al. 2003), and not vice versa (Seglen 1997). Based on this same logic, it should be the citations to a herpetologist's articles that determine his/her impact on herpetology.

Among the author citation indexes available, the h-index (Hirsch 2005), g-index (Egghe 2006a,b), e-index (Zhang 2009), and m-quotient (Bornmann et al. 2008) are the most familiar. Each of these is a refinement of the original h-index; consequently they are mathematically related to one another. Despite its deficiencies, the h-index (Hirsch 2005) is probably the most widely used of the author citation indices. Hirsch defined the h-index as follows:

"A scientist has index h if h of his/her N_p papers have at least h citations each, and the other (N_p-h) papers have no more than h citations each," (Hirsch 2005).

For example, if an author had 45 publications and among these one received 30 citations, a second had 10 citations, and a third had three citations, but all of the remaining publications had ≤ 3 citations; then the author's h-score would be h = 3. In this manner, the h-index provides a quantitative, objective way to compare authors with similar publication counts. However, the h-index normally continues to increase as the scientist's research career ages. This makes it difficult to compare the productivity of individuals at different stages of their careers. It also does not recognize citations of papers beyond what was needed to establish the h- score. The h-index will not distinguish between an author with three articles, each with three citations and an author with 100 articles, each with three citations; nor does it distinguish between an author with three papers each with 100 citations and an author with three publications each with only three citations (Egghe 2006a, b). Further, the time it took to accumulate the citations is ignored. Clearly, these deficiencies leave many questions when examining h-scores of authors. A related author citation metric is Zhang's e-index (Zhang 2009). This metric is used to account for excess citations via a complex mathematical operation. From a practical perspective, as the e-score decreases, the confidence in the h-score increases. Its aim is to distinguish between scientists with similar h-scores but different citation patterns.

The g-index is an author citation rating that accounts for highly-cited papers occurring in a portfolio of less-cited papers. It gives more weight to highly-cited articles as follows:

"[given a set of articles] ranked in decreasing order of the number of citations that they received, the g-index is the (unique) largest number such that the top g articles received (together) at least g^2 citations," (Egghe 2006a,b).

The g-index complements the h-index and does not replace it (Harzing 2008). Many of the problems with the h-index are also present with the g-index. There is no distinction made between older and newer articles having the same number of citations. This is a problem because a ten-year-old article by an artifact of its age should have more citations than a more recent one (Rinia et al. 2004). The m-quotient is an attempt to account for older investigators by dividing the h-score by the length of time since one's first publication in years (Bornmann et al. 2008).

Unfortunately, none of the different ways of comparing authors accounts for differences among disciplines (Seglen 1997), so it is very difficult to make accurate comparisons between a herpetologist and an ornithologist or an animal ecologist and a microbiologist. The number of scientists and journals in a discipline strongly influences the opportunity to be cited (Moed 2005). Larger fields tend to have higher citation rates and vice versa. These influences on citation scores are important to understand when examining these numbers (Hyland 1999).

Herpetology as a science is one of the smaller disciplines, and even then it is comprised of two different fields, amphibian biology and reptile biology (arguably three fields now that turtles are rightfully separated from reptiles [Krenz et al. 2005]). For example, the American Ornithologist's Union states that "its membership is about 4,000" (http://www.aou.org [last accessed 13 June 2010]) and the American Society for Mammalogy lists its membership at about 4,500 (http://www.mammalsociety.org/aboutasm/index.html [last accessed 13 June 2010]). Conversely, the Society for the Study of Amphibians and Reptiles had ~2,200 members (Brian Crother, pers. comm.) and the *Societas Europaea Herpetologica* had a 2004 membership of only 382 active members (http://www.seh-herpetology.org/ [last accessed 13 June 2010]). Clearly, there are far fewer opportunities for citation of an author's articles by other herpetologists than there are for either mammalogists or ornithologists because there are simply far fewer active investigators in herpetology. It is a standard practice that citation ratings should be compared among journals or investigators within a discipline and not among journals or investigators from different disciplines (MacRoberts and MacRoberts 1989).

Table 1. Observed variation of author metrics for herpetologists from each demographic level and the regression results for these data.

Years since first publication (N = number in sample)	h	g	e	m	Total publications Mean	Total publications Median	Career length (yrs)
Mean (N = 166)	9.35	16.18	12.18	0.33	53.68	20.50	25.27
SE_{mean}, quartile range for median	0.76	1.39	1.04	0.02	5.96	4-71	1.30
0-5 yrs (N = 16)	1.31	1.88	1.44	0.18	4.38	1.50	3.50
SE_{mean}, quartile range for median	0.30	0.51	0.42	0.06	1.25	1-7	0.32
6-10 yrs (N = 27)	2.56	3.78	3.38	0.28	8.15	6.00	7.96
SE_{mean}, quartile range for median	0.39	0.64	0.52	0.04	1.72	2-12	0.25
11-15 yrs (N = 16)	5.25	8.69	6.69	0.36	23.19	9.00	12.50
SE_{mean}, quartile range for median	1.32	2.15	1.45	0.08	8.84	5-27	0.39
16-20 yrs (N =13)	8.15	13.62	10.38	0.43	31.80	23.00	17.39
SE_{mean}, quartile range for median	2.39	3.93	2.60	0.13	11.10	4-45	0.45
21-25 yrs (N = 14)	6.21	10.21	7.31	0.26	26.07	23.50	22.71
SE_{mean}, quartile range for median	1.16	2.06	1.49	0.05	5.97	6-36	0.37
26-30 yrs (N = 14)	8.36	16.00	13.32	0.34	44.40	26.0	28.56
SE_{mean}, quartile range for median	1.69	3.23	2.58	0.07	12.20	7-71	0.29
31-35 yrs (N = 23)	10.61	18.26	13.84	0.30	67.50	37.0	32.96
SE_{mean}, quartile range for median	1.49	2.75	2.37	0.04	16.20	9-97	0.29
36-40 yrs (N = 13)	17.00	30.38	22.05	0.39	109.00	108.0	37.23
SE_{mean}, quartile range for median	2.71	5.12	3.72	0.07	21.10	33-185	0.44
41-45 yrs (N = 11)	16.27	26.45	18.46	0.42	99.20	80.0	42.36
SE_{mean}, quartile range for median	3.97	6.75	4.67	0.12	31.70	25-153	0.34
Mean 46-50 yrs (N = 9)	16.33	29.67	22.87	0.34	91.90	52.0	47.11
SE_{mean}, quartile range for median	2.46	4.64	4.90	0.05	26.00	41-116	0.42
Mean > 50 yrs (N = 10)	27.70	49.80	36.35	0.41	196.20	183.0	64.40
SE_{mean}, quartile range for median	4.05	8.04	6.37	0.05	37.80	123-273	2.80
$r^2_{\text{years since 1st publication}}$	0.498	0.494	0.456	0.027	0.448		--
P	< 0.01	< 0.01	< 0.01	0.035	< 0.01		--
Power	1.0	1.0	1.0	0.581	1.0		--
$r^2_{\text{number of publications}}$	0.787	0.747	0.644	0.321	--		--
P	< 0.01	< 0.01	< 0.01	< 0.01	--		--
Power	1.0	1.0	1.0	1.0	--		--
$r^2_{\text{years} \times \text{publications}}$	0.817	0.782	0.686	0.391	--		--
P	< 0.01	< 0.01	< 0.01	< 0.01	--		--
Power	1.0	1.0	1.0	1.0	--		--

Because citation indices are rapidly becoming popular and because herpetologists have a disadvantage relative to other biologists in respect to citation opportunities and index scores, it is critical for the health of herpetology as a science that we understand how author citation indices develop during the career of herpetologists. Herein, I calculate the above discussed author metrics using Harzing's Publish or Perish 3.0.3813 (Harzing 2010) and then investigate how these values change as the length of herpetologists' careers increase.

Materials and Methods

I randomly selected a sample of individuals from the 382 names on the 2004 membership list of the *Societas Europaea Herpetologica* using the randomization function in Microsoft Excel. Sample size was determined using statistical power analysis to be 95% certain that our results fit the 95% confidence level based on the SEH membership.

Although there are at least three sources (e.g. Web of Science, Scopus, and Google Scholar) from which author citation indices are available, I used Harzing's Publish or Perish to access the Google Scholar database because it is available online at no cost, it appears to access the widest number of scientific publications, and because previous studies suggest there is no clear advantage of using one of these databases over the other (Bakkalbasi et al. 2006).

I inserted each name into Harzing's Publish or Perish and then examined the divulged results. Articles that appeared multiple times were united using the new interface in Harzing's Publish or Perish, and any inaccurately retrieved papers were removed from the author's results by unchecking the data point. If I was unable to disassociate multiple authors, I removed this individual from the study and replaced it with a new name that was randomly chosen from the unused SEH members. Further, if an author's name did not exist in the Google Scholar database, then I excluded it from the study and replaced it as previously discussed. For a member to be included in the sample for this study, Harzing's Publish or Perish must have retrieved at least one publication from the Google Scholar Database.

I recorded each author's citation score (h-index, g-index, e-index, m-quotient), the year in which each author published its first paper and the number of publications each author produced as reported by Harzing's Publish or Perish. Then, I deleted all investigator names from the database in order to retain anonymity, although all of this data is public information. I calculated the number of years since each herpetologist's first publication. I used one-way analysis of variance with Tukey's pairwise comparisons to identify if differences existed among the m-quotients of the age groups to verify that this was an age-independent author metric for herpetologists. Then I ran a separate simple linear regression for each author citation index in which the citation metric was the response variable and the number of years since the author's first publication was the predictor. After this analysis I ran a regression to determine if the number of publications by a given author was a predictor of its citation score for each author citation index. I then calculated the post-hoc statistical power for each regression. Finally, I queried Google for 10 unidentified herpetologists who were not part of the model and who roughly represented a spectrum of career lengths and publication counts. I compared the model predictions to their actual author metrics and the observed averages in order to demonstrate how these metrics may be used for comparing herpetologists. In all statistics I used $\alpha = 0.05$ for decision theory.

Results

Of the original 382 names, 60 were unusable because they were (1) institutions, (2) herpetologists with no publications accessed by Harzing's Publish or Perish, or (3) herpetologists whose names were impossible for me to disassociate from other investigators with identical names. This adjusted the population to 322 herpetologists. Statistical power analysis provided that a sample of 166 SEH members would be sufficient to be 95% certain that our results fit the 95% confidence level based on the adjusted SEH membership population. Harzing's Publish or Perish provided author citation index scores and publication rates for all 166 of these herpetologists (Table 1).

Citation index scores vary among groups. An average herpetologist's h-score (range = 0-47) is around 1.3 (range = 0-4) during his/her first five years. It rises to 2.56 (range = 0-8) by the end of a herpetologist's first decade, and reaches 8.15 (range = 1-33) after 20 years of publishing. The same herpetologist's g-score (range = 0-87) will start out around 1.88 (range = 0-7), rise to 3.78 (range = 0-15) by the end of its first decade and then reach 13.62 (range = 1-50) at the end of 20 years. Likewise, the e-score (range = 0-70.6) starts out around 1.44 (range = 0-5.1), grows to 3.78 (range = 0-12.21)

Table 2. L Linear models for predicting author citation index scores and publications based on length of career and productivity of herpetologists. (*indicates a model with low Power, see Table 1).

	X = years since first publication	**z = Number of publications**	**X = Years since first publication Z = number of publications**
h =	0.414x – 1.11	0.114z + 3.25	0.133x + 0.0948z + 0.898
g =	0.748x – 2.73	0.201z + 5.40	0.263x + 0.164z + 0.740
e =	0.540x – 1.46	0.140z + 4.67	0.215x + 0.110z +0.870
m =	0.00267x – 0.258*	0.00201z + 0.217	-0.00567x + 0.00281z + 0.318
Publications (N) =	$0.036x^2 + 0.735x + 1.98$	--	–

Table 3. Calculation of author publication metrics for 10 random herpetologists obtained via Google queries using Harzing's Publish or Perish. I used the models from Table 2 which demonstrated tight r^2 relationships (Table 1). The numbers in parenthesis refer to the number of the row in Table 3 containing the data used to predict the given metric. Differences between the actual numbers and either the predicted values (below) or the average values (Table 1) reflect the herpetologist's higher or lower productivity level relative to what is expected.

	A	B	C	D	E	F	G	H	I	J
1. Years since 1st Publications	6	7	9	11	13	15	37	48	52	79
2.Observed Publications (N)	13	1	6	21	12	31	183	200	18	193
3.Predicted Publications (N)	6.6	7.4	8.9	10.4	12.0	13.5	30.5	39.0	42.1	62.9
4. Observed h-score	3	1	2	6	7	5	14	31	5	36
5. $h_{Predicted}$ based on (1)	1.4	1.8	2.6	3.4	4.3	5.1	14.2	18.8	20.4	78.8
6. $h_{Predicted}$ based on (2)	4.8	5.5	3.9	5.6	4.6	6.8	24.1	26.1	5.3	25.3
7. $h_{Predicted}$ based on (1 × 2)	2.9	1.9	2.7	4.4	3.6	5.8	23	26.2	9.5	29.7
8. Observed g-score	7	1	6	8	12	6	18	45	7	63
9. $g_{Predicted}$ based on (1)	1.8	2.5	4.0	8.2	9.7	8.5	24.9	35.9	36.2	56.4
10. $g_{Predicted}$ based on (2)	8.0	5.6	6.6	4.2	7.8	11.6	42.2	45.6	9.0	44.2
11. $g_{Predicted}$ based on (1 × 2)	4.5	2.7	4.1	7.1	6.1	9.8	16.5	46.2	17.4	53.2
12. Observed e-score	6.5	2.45	5.6	4.69	12.3	3.16	9.06	27.4	4.9	44.6
13. $e_{Predicted}$ based on (1)	1.78	2.3	3.4	4.5	7.0	6.64	19.98	24.5	26.6	41.2
14. $e_{Predicted}$ based on (2)	6.5	4.8	5.5	7.6	6.4	9.01	30.3	32.67	7.2	31.7
15. $e_{Predicted}$ based on (1 × 2)	3.6	2.5	3.5	5.5	5.0	9.8	29.0	33.2	14.0	39.1
16. Observed m-quotient	.50	.14	.22	.55	.54	.33	0.38	.65	.10	.46
17. $m_{Predicted}$ based on (2)	.24	.22	.23	.26	.24	.58	0.58	.62	.25	.60

after 10 years and to about 10.38 (1.41-31.1) after writing for 20 years. The m-quotient is not influenced by age, although changes in an author's publishing could alter its value. The average m = 0.33 (range = 0-1.83) among all herpetologists. Publication counts (range = 1-404) generally rise throughout the career of a herpetologist with early investigators having about 4 publications (range = 1-16). This grows to eight by the end of 10 years (range = 1-41) and then to 32 (range = 1-150) after 20 years of publishing.

The proportion of herpetologists with fewer than 10 publications falls as time since release of their first publication lengthens. Of the herpetologists whose first publication was less than 10 years ago, 70.5% had fewer than 10 publications. However, of the 126 herpetologists whose first publication came out more than 10 years prior, 24.6% had fewer than 10 publications in their career. Of those 93 herpetologists whose first publication came out more than 20 years ago, 18.1% had fewer than 10 publications, and of those whose first publication came out over 30 years ago, only 13.8% had fewer than ten publications. The number of years since a herpetologist's first publication was a good predictor of all the author metrics except the m-quotient (Table 1). There were no significant differences among the m-quotients of the different age groups ($F_{10, 155}$ = 1.09, P = 0.375). The number of publications was a good predictor of all author metrics. Multiple regression with the years since an author's first publication and the quantity of publications as predictors provided models (Table 1, 2) to calculate expected metric values for herpetologists based on its career length (Table 3).

Discussion

Harzing's Publish or Perish is an easily used free software program for analyzing author publication metrics via the Google Scholar database. The results demonstrate that most author publication metrics are related to the length of a herpetologist's career and the number of publications in his/her portfolio. This program does not retrieve all of the articles of an author's portfolio, but previous studies demonstrate that neither does Scopus nor Journal Citation Reports, and Harzing's Publish or Perish is sufficiently accurate to provide useful and meaningful information about an author's productivity (Bakkalbasi et al. 2006).

The h-score increases as the career length of a herpetologist increases; however, the scatter in that data also increases. Undoubtedly, as people grow older, circumstances come about that make continuing research difficult. The longer the career, the more likely that outside influences could interfere with research productivity. So, it is not surprising to see the error increase late in a herpetologist's career. Because the g-index is closely related to the h-index, the g-score value follows a very similar pattern of development to the h-score. If one compares the h-score to the g-score, it can provide useful information about the development of a herpetologist's career. For example, the more disparity between the h-score and g-score, the more highly-cited papers that author has relative to its total of cited papers. Herpetologists tend to have very similar h- and g-scores early in their career, but the g-score generally out-performs the h-score to such an extent that after 20 years the average g-score almost doubles the average herpetologist's h-score (Table 1). This results because some papers accumulate many more citations than others, increasing the g-score.

As the e-score decreases, the confidence we have in the h-score for any given herpetologist increases. The e-score rises substantially during the career of a herpetologist. This means that there is a large amount of variation in the h-scores of older herpetologists and less variation among early-career individuals. This follows and reinforces the findings from my earlier analysis which suggests the h-score becomes harder to characterize late in a herpetologist's career. The large spread in h-scores among late career herpetologists makes it more useful for comparing among a group of older investigators than it is for younger herpetologists, but the mean, median and standard error of those values are less useful as benchmarks for older herpetologists than they are for younger ones. An important consideration is that as herpetologists leave the discipline for non-professional reasons (e.g. health) late in their career some caution in interpretation is warranted.

The m-quotient controls for the investigator's age, allowing comparison of older and younger herpetologists. All of the standard errors for m among the various age groups overlap providing that there are no differences among age groups (Table 1) and the ANOVA results demonstrate that the m-quotient is consistent across all age groups. The regression results demonstrate that there is virtually no increase in m-index score with an increase in the length of a herpetologist's career (Table 1, 2). Therefore, if we want to compare established herpetologists with those who are newer to the field, the m-quotient may be a useful author citation rating, but we should use the overall all mean and SE (0.33 ± 0.02) as a reference point rather than the average m-quotient from any specific age group due to the statistical analyses above.

Herpetologists accumulate more publications as their career lengthens (Table 1). The average herpetologist publishes just fewer than one publication per year during the first 10 years of its career. Either herpetologists are more productive in the second decade of their career or herpetologists whose papers are less cited leave the discipline after their first decade. I am unable to determine which of these factors is true, and a combination of these factors is possible. However, herpetologists whose careers enter their second decade are much more productive (over 1.5 publications/year) than those in their first decade (0.83 publications/year). The trend continues into the third and fourth decades as publication rates appear to accelerate with age. Either that or more productive herpetologists have longer careers.

Our models can be used to calculate expected author metrics based on their career length, number of publications, and both factors simultaneously (Table 3). Herpetologists A, B, and C (Table 3) were early in their career. Herpetologists D, E, and F were mid-career scientists, and G, H, and I were late in their career. Herpetologist J had an unusually long career. The models become less useful for predicting publication counts as the career length of a herpetologist increases. The model predicted publication counts based on the career length of the three herpetologists from this age bracket to within one SE of the expected mean (Table 3). The model is inaccurate for herpetologists whose first publication was only a year old, providing a predicted value (2.75) that is between 1-2 standard errors from the mean for the 0-5 year bracket. However, the model is accurate for those whose first publication was between 2-10 years earlier. The model consistently underestimates the publication counts of herpetologists whose first publication came out over 10 years earlier (Table 1, 3). There is much more scatter in publication counts among older herpetologists relative to younger ones, and about 25% of herpetologists whose first publication came out over 10 years ago have fewer than 10 publications. It is difficult to decipher who among this group has fewer publications due to termination of research activities and who is simply less productive. This requires information to which I do not have access to further refine this relationship.

Although this study addresses only the career length and publication numbers as predictors of author citation metrics, it is plausible that herpetologists working at research universities may have higher author metrics than those who work at small teaching schools, and those who work outside of academia may have very erratic publication patterns depending on the nature of their employment. I was unable to analyze these possibilities because of insufficient sample size. However, this would be an interesting avenue to investigate as these tools become more important to our discipline. Finally, this study is based on the most recent author metrics for herpetologists who were SEH members in 2004. Whether or not that group is representative of the membership of all herpetology societies, or other national-level societies is debatable; however, I suggest that the strong power ratings and low p-values combined with the fact that SEH publishes a highly rated herpetology journal included in Journal Citation Reports (Thomson-Reuters, Inc.) provides reasonable confidence for extrapolating these findings to the larger population of herpetologists in general.

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