FEATURE:
PROFESSIONAL ISSUES

Exploring the Peer Review Process: What Is It, Does It Work, and Can It Be Improved?

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ABSTRACT: Though peer review is central to science, the process itself has received little formal evaluation. Here we provide an overview to the literature on the peer-review process. Peer review has its drawbacks, including financial cost, time, reliability, and potential biases. An important gap in our knowledge is whether the process works. Although most manuscripts show some improvement after peer review, reviewers often disagree, and errors can escape the process. To date, we do not know whether papers published with peer review are generally improved over those without. Most journals use a single-blind approach (author blind to reviewers), whereas others use a double-blind approach, and a few use an open approach. Biases toward authors (institutional, geographic, gender) apparently exist in some fields. Unlike the formal training we receive in fisheries research and management, no formal training process exists for peer review—without mentoring, how are new reviewers produced? Based on our literature survey, we recommend consideration of double-blind review, implementation of a rating system for reviews of submitted manuscripts, and training and mentoring students to become good reviewers.

Exploración del proceso de revisión por pares ¿Qué es, cómo funciona y puede mejorarse?

RESUMEN: Si bien el proceso de revisión por pares es fundamental para la ciencia, éste no ha sido formalmente evaluado. Aquí se muestra un panorama de la literatura acerca del proceso de revisión por pares. Este proceso tiene varias fallas que incluyen el costo financiero, tiempo, confiabilidad y potenciales sesgos. Existe un importante hueco en nuestro conocimiento acerca de si el proceso realmente funciona. A pesar de que algunos manuscritos muestran una mejoría después de la revisión por pares, los árbitros a veces discrepan entre ellos y algunos errores pueden escaparse del proceso. A la fecha, no se sabe si los artículos arbitrados son mejores que aquellos que no lo son. La mayor parte de las revistas se basan en un enfoque de arbitraje sencillo-ciego (el revisor desconoce al autor) mientras que otras utilizan un enfoque de arbitraje doble-ciego y sólo algunas usan un enfoque de apertura total. La discriminación hacia los autores (por institución, ubicación geográfica y género) aparentemente existe en algunas disciplinas. De manera contraria al entrenamiento que se recibe en la investigación y manejo de pesquerías, no hay un proceso de entrenamiento formal—no existen mentores, para la revisión por pares ¿entonces cómo se producen los nuevos revisores? Sobre la base de esta revisión, se recomienda tomar en cuenta el enfoque de arbitraje doble-ciego, la implementación de un sistema jerarquizado de revisores para los manuscritos sometidos y una buena tutoría hacia los estudiantes para que se conviertan en buenos árbitros.

The phrase "peer review" can elicit an array of responses from scientists, including respect, fear, apathy, and downright anger. For nearly three centuries (Kronick 1990), peer review has provided quality control for the data entering the published literature. The long history of peer review, combined with its importance (careers depend on satisfying one's peers), has generated a huge literature. For example, in our literature survey we considered > 220 papers. Even so, much of this literature (about 60% of these papers) occurred in editorial, opinion, or commentary papers as opposed to controlled studies. To demonstrate how little our field has formally reflected on this process, only five of those papers were from the fisheries literature (Brown 1995; Hansen 2002; Jolley and Graeb 2007; Amos 2008; Cooke 2008), with about twice that number from the broader ecological literature. As an indication of our collective interest in peer review, one of the early experimental studies in peer review (Peters and Ceci 1982) has been cited 282 times. A quick scan through our literature cited section will reveal that the papers dealing with peer review exist in outlets that are probably not typically read by fisheries scientists or ecologists. Using this body of literature, we describe peer review, assess its success, consider potential concerns, and reflect on possible alternatives. We end by presenting some characteristics of a good peer review and how we, as scientists, learn to provide one, offering one training approach with which we have experience.

WHAT IS PEER REVIEW?

In peer review, experts evaluate a manuscript in an effort to assist editors in deciding if a submitted manuscript is worthy of publication, i.e., does it meet the standard for scientific rigor for that journal? Through peer review, manuscript shortcomings should be identified and corrected, and manuscript originality assured. The manuscript should be improved by peer review, and critically flawed research should be rejected. Whereas peer review clearly applies to areas beyond publication (e.g., grant proposals), in this article we generally limit our discussion to peer review of completed work or manuscripts.

The peer review process varies among journals (Bachand and Sawallis 2003); however, most journal

editors ask experts to critically evaluate the submitted manuscript. Typically, editors ask for detailed recommendations that serve to inform an acceptance/rejection decision. Four of our American Fisheries Society (AFS) journals (*Transactions of the American Fisheries Society* [TAFS], *North American Journal of Fisheries Management* [NAJFM], *North American Journal of Aquaculture* [NAJA], and *Journal of Aquatic Animal Health* [JAAH]) use an editor, an associate editor who is a subject-matter expert, and peer reviewers. In this model, manuscripts are sent to two to three reviewers by the associate editor. Whereas the associate editor is known to the reviewers, both reviewers and the associate editor remain anonymous to the author. The associate editor receives the reviews, critically reviews the manuscript in light of the reviews and his/her expertise, and then provides both a review summary and a recommendation to the editor. The editor reviews the manuscript (ideally), uses all submitted information to make an acceptance/rejection decision, and communicates directly with the author.

Even though peer review is the critical evaluation of a manuscript by experts before publication, we suggest that the peer review process includes three stages:

1. A preliminary review by the editorial staff to determine if the manuscript is suitable for the journal (screening),
2. A formal peer review (including review of the original submission and subsequent revisions), and
3. The continuing "review" upon publication when peer scientists read and evaluate the paper (Koch 2001; Erren 2007).

Relying on this description, many readers of a journal paper bypass stage 3, accepting the published paper as fact, given it has been peer reviewed. Those who have reflected more formally on this process express both their support and concerns: "an essential component of scholarly publishing" (Mulligan 2005), "absolutely fundamental to the decision making process for publication" (the British Academy as stated by Croll 2007), "a treacherous servant" (McCutchen 1991), "a flawed process" (Smith 2006), and "a series of interactions among the editor, reviewers, and author" (Weller 1991). Williamson (2003) argued that peer review relies on trust and integrity among scientists, with Raelin (2008) likening peer review to a game with high stakes (e.g., academic careers). Authors also have applied the famous Winston Churchill quote ("Indeed it has been said that democracy is the worst form of government except all those other forms that have been tried from time to time"; 11 November 1947 speech to the House of Commons) to argue that peer review, while flawed, remains the best system to serve as gatekeeper to the published literature (e.g., Robin and Burke 1987; Rennie 2003a; Fisher and Powers 2004; Alpert 2007).

At its core, peer review provides an editor with insight into the quality and suitability of a manuscript. By the end of peer review, editors should have the information to successfully separate "good" from "bad" science (McCoy 1993); indeed it remains the editor's decision as to whether a manuscript is published, revised, or rejected (i.e., reviewers do not vote, they only provide input; Michels 1995; Northcraft 2001; Cooke 2008). As such, peer reviewers provide input to four groups:

1. The editor who requested the review,
2. The author,
3. The journal readers, and
4. Even to themselves as reviewers (Williamson 2003; Council of Science Editors 2006).

In reality, the responsibilities of the reviewer to the editor, the author, and the readers are similar—peer reviews should be critical, but objective and fair, produced in a timely fashion, and allow for creativity while not allowing the submitted work to go too far beyond what the data support. In addition, even manuscript authors who are rejected for publication in one journal can benefit from constructive review comments (Weller 1996; however, see the concern by Kearney and Freda 2005 about the lack of concrete comments provided by peer reviewers). Typically, reviewers provide expertise likely not shared with the editor and many of the readers (Rennie 2003a), assuring that a manuscript is evaluated by experts in the field. Value added for the reviewers is recognition among their peers, as well as by supervisors during evaluations (e.g., via annual journal reviewer lists), and the opportunity to stay informed about the most current work in their field. In some cases (e.g., Williamson 2003; continuing education credits in Glick 2007; monetary example in Adam and Knight 2002), incentives are provided to reviewers directly, although this appears to be relatively rare in our discipline. In a reviewer survey, Tite and Schroter (2007) discovered that small monetary incentives likely would not increase the possibility of a manuscript review in the face of time constraints, although non-financial incentives (e.g., free journal access, annual reviewer acknowledgment, feedback regarding their review and the final decision, potential for future invitation to serve on the editorial board, credit toward page charges for their next paper) were viewed positively. Given that most reviewers are also authors, manuscript review becomes a high priority, knowing that their own submitted manuscripts must be reviewed.

Time required by peer review seemingly accounts for most of the time required for overall manuscript evaluation, with most delays driven by tardy reviews (Fisher and Powers 2004). As an example, we considered data from 2004–2006 in the four AFS journals—*Transactions of the American Fisheries Society*, *North American Journal of Fisheries Management*, *Journal of Aquatic Animal*

Table 1. Publication time data during 2004–2006 for four American Fisheries Society Journals (*Transactions of the American Fisheries Society* [TAFS], *North American Journal of Fisheries Management* [NAJFM], *North American Journal of Aquaculture* [NAJA], and *Journal of Aquatic Animal Health* [JAAH]), including the mean (± 1 SE) time spent in review, the mean (± 1 SE) percent of time spent in review as a function of the time between submission and initial editor decision, the mean (± 1 SE) time taken for an author to revise a manuscript, and the mean (± 1 SE) percent of time spent in revision as a function of the time between manuscript submission and final editor decision.

	Days in review	% in review	Days in revision	% in revision
TAFS (04-06)	59.3 ± 2.0	53.4 ± 0.9	106.7 ± 3.3	38.9 ± 0.9
NAJFM (04-06)	49.5 ± 1.3	60.0 ± 0.8	98.4 ± 3.3	38.6 ± 0.9
JAAH (04-06)	41.3 ± 2.3	50.8 ± 1.7	70.6 ± 6.2	32.6 ± 1.9
NAJA (04-06)	44.7 ± 2.3	58.8 ± 1.5	66.8 ± 4.6	36.1 ± 2.2

Health, and *North American Journal of Aquaculture*. The number of days a journal submission spent in review varied among journals, ranging from 41 to 59 days, but requiring between 51 to 60% of the time between manuscript submission and initial editor decision (Table 1). A second large portion of time spent between submission and eventual publication lies with the authors in fashioning their revised manuscript. Again, for the four AFS journals during 2004–2006, manuscripts spent between 67 and 107 days in revision, taking up 33–39% of the time between manuscript submission and final editor decision (Table 1). Hence, both reviewers and authors contribute to turnaround time for manuscript publication.

DOES PEER REVIEW WORK?

Determining whether peer review works depends on what it is asked to do, and as we demonstrated above, defining peer review is not simple. At one level, we might ask, are peer-reviewed manuscripts "better" than those rejected by this process? Is "bad" science denied publication? Clearly, these are not easy questions to answer (Jefferson et al. 2002) and they have been approached from a variety of perspectives, including comparing manuscripts before and after peer review, assessing peer review before and after manuscripts have been modified, comparing peer-reviewed and non-peer-reviewed manuscripts, and assessing agreement of peer reviews of the same manuscript. Each approach has advantages and disadvantages, but each provides a glimpse into the overall picture of peer review effectiveness.

Forty-four assessors evaluated 111 manuscripts accepted for publication in the *Annals of Internal Medicine*, conducting their evaluations both at submission and at acceptance (Goodman et al. 1994). A 34-item evaluation (with a 1–5 scale for each item) was used to assess study aims, methods and design, analyses conducted, discussion, conclusions, etc. With this approach, Goodman et al. (1994) concluded that 33 of 34 items improved, arguing that peer review and editing improved manuscript quality. Similarly, Roberts et al. (1994) used two validated indices (the Gunning fog index and the Flesch reading ease score) to assess the readability of 101 manuscripts submitted to the *Journal of the American Medical Association* before and after peer review/editing, concluding that peer review improved readability. Thus, while these studies demonstrate that peer review likely improves a manuscript, they do not necessarily speak to whether peer review weeds out bad science.

To evaluate peer review in a more controlled way, studies have used resubmissions of previously published papers, or have inserted known errors into papers, then sent them for evaluation. Peters and Cici (1982) selected 1 paper each from 12 highly regarded psychology journals, changed authors and institutions to fictitious ones, and resubmitted them to the original journal (published 18–32 months earlier). Of 38 editors and reviewers, only 3 (8%) detected the resubmissions, and 9 of the 12 articles were peer reviewed. Of these, 8 were rejected (89% of those originally accepted), with 16 out of 18 reviewers recommending rejection, including mention of "serious methodological flaws." Using a different approach, Godlee et al. (1998) inserted 8 weaknesses into a published paper, and sent it out for review. Mean number of inserted errors detected by reviewers was 2, with only 10% identifying 4 or more, while 16% did not identify any inserted errors. Similarly, in a study where the authors constructed a manuscript they described as "a fictitious but believable study," Baxt et al. (1998) included 10 major errors and 13 minor errors, submitting it to the reviewer database for a journal (*Annals of Emergency Medicine*). Of 199 reviews with recommendations, 15 recommended acceptance, 117 rejection, and 67 revision. The errors the reviewers identified differed among recommendation groups, ranging from 17 to 39%. Surprisingly, 68% of the reviewers did not recognize that the conclusions were not supported by the data! Nearly 2/3 of the major errors were not identified by the reviewers. This controlled approach to evaluating the effectiveness of peer review, in addition to several new techniques published more recently (van Rooyen et al. 1999a; Landkroon et al. 2006), offer promise for future studies of peer-review effectiveness. In addition, the use of an index of quality that editors assign to each review has helped to provide some measure of review quality for some journals (e.g., *The American Journal of Roentgenology*; *Annals of Emergency Medicine*; Callaham et al. 1998a)

Another approach to evaluating the peer review process has been to assess how closely reviewers of the same manuscript agree. In summary, reviewer agreement has generally been low, but better than chance (e.g., Scott 1974; Cicchetti 1980; Marsh and Ball 1981; Plug 1993; Howard and Wilkinson 1998; Rothwell and Martyn 2000; Kemp 2005; Loonen et al. 2005). Complete agreement may be impossible, given that reviewers have different areas of expertise, leading to different assessments. Indeed, authors must have trust that editors will incorporate reviewer background, potential biases, etc., into their eventual acceptance/revision/rejection decision.

CONCERNS WITH PEER REVIEW

Peer review has been critiqued as slow, expensive, unreliable/inconsistent, and potentially biased. Clearly, the review process takes time. Given that reviewers are also authors, we expect reviewers should be sensitive to turnaround time. However, time demands in our science continue to climb. Couple these demands with the increasing numbers of journals and one can understand why turnaround times for manuscript review are long. Whereas the digital age has certainly saved time previously used by regular postal mail, overall time from submission to the first editor decision (i.e., not including manuscript revisions) remains at about 13.4 weeks for AFS journals (data combined for all four AFS journals during 2004–2006).

Though we rarely consider costs involved with reviewing, they are very real, both in time and dollars. Peer review accounts for 2.6–7.5% of total journal costs for journals surveyed (Fletcher and Fletcher 2003), and estimates of the actual cost per article published ranged from US$200 to US$2,500 (Donovan 1998; Smith 2006). Relative to personnel time costs, one estimate has the mean time for a review at 3 h, with a range from 0.5 to 16 h (McNutt et al. 1990). For the *New England Journal of Medicine*, Relman (1990) estimates the annual cost of peer review to the journal is about US$1 million, with an additional 15,000–20,000 h of volunteer reviewer time! No such evaluations of financial or time costs have been published for our discipline, but given the importance of peer review to our field, perhaps this should be explored.

Bias in peer review has received some attention and can occur at any stage of the publication process, including the initial decision of whether to review a manuscript (c.f., rejecting it without any external peer review) and during peer review itself. By not sending a manuscript out for peer review, an editor must feel that the manuscript does not (1) meet the journal's scope or (2) meet its minimum requirements for publication. Such pre-

review screening can save substantial time for both reviewers and authors (Groves and Abbasi 2004; Raveendran 2006; Johnston et al. 2007), although a negative decision with such a quick turnaround is certainly not what authors prefer. Though the potential for bias exists, we know of no study of bias during this pre-review screening stage.

Bias in peer review can influence publication, through characteristics of the paper itself (e.g., innovation, statistical results, study species), as well as characteristics of the author (e.g., geographical location, institutional affiliation, gender). Although the peer review process could potentially stifle creativity and innovation (Horrobin 1990, 2001), no conclusive evidence exists to support this perspective (recently reviewed in Rennie 2003b). Another characteristic is termed "publication bias," where papers published tend to have positive results, rather than negative ones. This phenomenon has been documented in psychology, education, social and behavioral sciences, and medicine (reviewed in Godlee and Dickersin 2003; see also Lortie et al. 2007 for ecology). Two experimental studies have supported this finding by submitting two different versions of the same paper for peer review, one with positive findings and one with negative ones (Mahoney 1977; Epstein 1990). In both cases, the version with positive results was favored. Clearly reviewers, associate editors, and editors should be aware of such "publication bias," so as to control for it.

Perhaps of even more concern is the potential for bias in the peer review process due to author characteristics. Papers published tend to be authored by individuals from the country of the journal publisher (e.g., reviewed in Godlee and Dickersin 2003; Lee et al. 2006). However, is this a bias in peer review or do authors select home-country journals for submission? Institutional affiliation of the author can contribute to bias (see the earlier example of Peters and Cici 1982, where names and affiliations of authors on papers were altered). From manuscripts submitted to *The Journal of Pediatrics*, Garfunkel et al. (1994) found that while no difference existed in acceptance rates of major papers across institutional ranks, brief reports from institutions with greater prestige were more likely to be accepted than were those from lower prestige institutions. However, given that paper quality was not evaluated, Garfunkel et al. (1994) could not relate their results to true bias. As such, the evidence for bias due to institutional affiliation is equivocal.

One characteristic of authors that has received attention relative to bias is author gender. When considering grant proposal peer review, several (but not all) studies have found gender bias in favor of males (postdoctoral applications, Weneras and Wold 1997; grant proposals, Bornmann et al. 2007; but see Grant et al. 1997). Interestingly, when studied relative to publication peer review, most studies have found little evidence of a gender bias in acceptance (e.g., Gilbert et al. 1994; Tregenza 2002; Lee et al. 2006), although detecting bias due to differential acceptance also would require an assessment of submission quality. One recent study stands out. Budden et al. (2008) compared authorship of articles published in two similar journals (*Behavioral Ecology* and *Behavioral Ecology and Sociobiology*, BES) before and after *Behavioral Ecology* switched from a single-blind (the author is known to the reviewers, but reviewers remain anonymous to the author) to a double-blind review system in 2001 (here both authors and reviewers are anonymous). Review at BES remained single-blind. Budden et al. (2008) tracked authorship in both journals during 1997–2000 and 2002–2005, finding a significant increase in female first-authored papers in the double-blind journal post change, while not seeing such an increase BES, suggesting that a gender bias indeed existed (but see Webb et al. 2008; Whittaker 2008; Hammerschmidt et al. 2008 for an ensuing discussion). Whether a similar bias exists in fisheries is not known, but we all must be cognizant of it and make every effort to eliminate it in our reviewing and editorial activities.

One important area of bias often not considered is reviewer selection. No clear instructions or rules exist to guide reviewer selection. Because finding good reviewers can be difficult, individuals providing insightful, well-justified reviews end up being called upon more frequently than their less insightful colleagues. In addition, many journals allow or even encourage authors to suggest reviewers. These reviewers may be used, depending on the editor, the subject of the paper, the expertise of the editor, etc. Whereas review quality does not appear to differ between author-recommended and editor-identified reviewers, author-recommended reviewers tend to be less critical and more likely to recommend acceptance (Earnshaw et al. 2000; Schroter et al. 2006; Wager et al. 2006; Rivara et al. 2007). Although Goldsmith et al. (2006) did not find a significant difference in the odds of a paper being accepted depending on whether the authors suggested reviewers or not, they did find a significant increase in the odds of being accepted if the authors named reviewers to be excluded (requests to exclude a reviewer were honored 95% of the time), suggesting the potential for negative bias. One final issue is the bias of the associate editor who may seek to subject the submission (for whatever reason) to a more intense review process by choosing reviewers with a reputation for intensely critical assessment. Again, trust among the players is important.

APPROACHES TO THE PEER REVIEW PROCESS

Most commonly, peer review uses the single-blind method (Publishing Research Consortium 2008). With this approach, reviewers are more likely to provide open and forthright reviews, given that their identity is kept from the author. This may be particularly important for early-career reviewers, who may fear retaliation from senior scientists as a result of critical reviews if reviewer identity was known. Author identity is provided to the reviewer for background expertise and to gain some insight into the author's previous work, although this could potentially allow for less rigorous review. This form of peer review has been criticized for not being fair in that the reviewers know who they are reviewing but the authors do not have the same privilege (secrecy may not be consistent with passing judgment of submitted work; Rennie 1998). By remaining anonymous to authors, reviewers are not necessarily held accountable to the authors for their comments, though they may feel accountable to the editor.

Variations on the approach include double-blind and open approaches. Double-blind peer review makes authors and reviewers anonymous to one another. Thus, any information that would serve to identify the author must be removed before review. Under an open peer review system, the authors and reviewers are identified to one another. These two approaches correct some of the presumed problems with the single-blind approach, while introducing problems of their own. Double blind allows the manuscript to be evaluated strictly on its own merits, without bias from an author's reputation, potentially improving the review process (Fisher et al. 1994). While labor intensive for editorial offices to remove author

information, reviewers often identify blinded authors (masking success = 60–68%; Ceci and Peters 1984; Cho et al. 1998; Justice et al. 1998; Katz et al. 2002), due to self-citation and citation of "in press" papers. In addition, some authors would prefer reviewers know their identity rather than for reviewers to guess incorrectly and allow that bias to guide their review. The open (or unmasked) approach is said to provide an ethical advantage (Godlee 2002), in that those passing judgment must be accountable to the author for their comments and evaluation, plus gaining credit for their contributions. Though this approach could lead to more thorough, rigorous reviews, given that the reviewer's reputation to the author is at stake (Carmi and Koch 2007), even under a single-blind system, reviewers are clearly accountable to the editor (Davidoff 1998). Criticisms include the possibility of payback for either positive or negative reviews in the future, given that reviewers and authors will probably interact through their careers, thus reducing the rigor of critical assessments. In addition, more reviewers may decline a request to review if they know they will be known to the author (van Rooyen et al. 1999b; Godlee 2002).

Double-blind approaches have been compared to single-blind ones. In several surveys, most respondents (56–84%) preferred double-blind peer review (Stensrud and Brooks 2005; Regehr and Bordage 2006; Smit 2006; Publishing Research Consortium 2008). Perhaps more important than participant perceptions is whether either one works better, in terms of review quality and potential biases. Most studies revealed only a slight increase in quality with a double-blind system, either in terms of identifying weaknesses that were inserted into an already-accepted paper (Godlee et al. 1998) or editor evaluation on a 5-point scale (McNutt et al. 1990; Justice et al. 1998; van Rooyen et al. 1998). However, as noted earlier, Budden et al. (2008) found an increase in the percentage of papers with a female first author after switching to a double-blind system. Clearly, bias may be reduced with a double-blind process with no loss of quality. American Fisheries Society journals should consider this option, though we know that it may be difficult in a field where geographic study locations likely could lead to author identification.

An open system where authors know reviewers is generally not preferred, with one survey reporting that only 13% of respondents preferred an open system (versus 56% for double-blind and 25% for single-blind; Publishing Research Consortium 2008). Similarly, a trial run of open peer review at *Nature* did not meet with much support (Greaves et al. 2006). Review quality did not differ between a single-blind versus an open system (but see Walsh et al. 2000), although acceptance rates are likely higher under an open system (Goodlee et al. 1998; McNutt et al. 1990; Justice et al. 1998; van Rooyen et al. 1998, 1999b), and open reviews are more courteous, take longer, and are more likely to recommend acceptance than anonymous reviews (Walsh et al. 2000).

Several other approaches to peer review have been described, but without critical review via the literature, we simply mention them here. One approach is an "as-is" process (Tsang and Frey 2007) where reviewers are given only two options for their recommendation—accept or reject. Reviewers do provide comments, which the authors can use as they deem necessary, submitting their revised manuscript with a point-by-point response. In this regard, it is somewhat similar to the approach now used in AFS journals, save for being double-blinded and limiting revisions to one. Other approaches take advantage of technological advantages of the Internet, including an open moderated approach (where manuscripts are posted for a moderated comment period prior to submission for regular peer review; Gura 2002); an interactive peer review process followed by public discussion (Poschl et al. 2004); posting of all intermediate versions of a manuscript, associated reviews, and author responses to the reviewer comments (Carmi and Koch 2007); an Internet collaboration approach (in *Scientific American*; Waldrop 2008); and a post-publication filtering approach (the Faculty of 1000; Wets et al. 2003). None of these approaches is used widely, and no conclusions can currently be drawn as to their effectiveness.

CHARACTERISTICS OF A GOOD REVIEWER

The literature is replete with advice about how to review a journal submission (e.g., Rosenzweig et al. 1988; Kuyper 1991; Waser et al. 1992; Brown 1995; Benos et al. 2003; Moher and Jadad 2003; Provenzale and Stanley 2005; Bearinger 2006; Bourne and Korngreen 2006). Given that our objectives do not include instruction on the mechanics of how to review, we point those interested to these references. Rather, we focus on whether reviewers might have specific characteristics that tend to lead to high quality reviews. We suggest that general characteristics of a good review include being critical, thorough, thoughtful, constructive (to the extent possible), and timely (Goldbeck-Wood 1998; Drotar 2009). However, in an effort to quantify review quality, a number of journals use a ranking system where editors or associate editors rank reviews on some scale. These scales are generally a 3- to 9-level system with varying levels of detail provided to the editorial board concerning how scores are to be assigned to individual reviews (e.g., Stossell 1985; Siegelman 1991; Evans et al. 1993; Feurer et al. 1994; Friedman 1995; Callaham et al. 1998a; Kliewer et al. 2005; Green and Callaham 2006; Jawaid et al. 2006). This approach has been supported by at least one study (Callaham et al. 1998a), ultimately providing a way to quantify review quality and compare reviewer characteristics (see below) with the quality of their review.

Although some researchers have attempted to compare review quality with reviewer characteristics, this has been met with mixed success. Two characteristics associated somewhat consistently with higher quality reviews have been lower academic or professional status or younger age (Stossel 1985; Evans et al. 1993; Black et al. 1998; van Rooyen 2001; Kliewer et al. 2005; Callaham and Tercier 2007), and more time spent on the review (up to a limit, after which no further increase occurs, Black et al. 1998). Other characteristics, such as peer review training, academic rank, gender, and years as a reviewer, were unrelated to review quality. Unfortunately, these findings (other than reviewer age!) do not help editorial boards increase the quality of their reviewer pool. Younger reviewers may work harder, or they may have more time available, while reviewers with greater expertise, time in the field, and rank may decline review requests more often (Stossel 1985). In our discipline, we should consider these factors as we try to balance experience or expertise with time in the profession when choosing reviewers.

LEARNING TO REVIEW

Most likely, few of us received formal training during our education in how to review a manuscript. Yet, we serve as reviewers and are expected to suddenly know how to craft a high quality review at some point between our undergraduate education and our first academic or agency job. So how do we learn to review?

Some students have advisors who mentor them in the review process, perhaps working with them one-on-one on manuscript review (Calleigh et al. 2001; Anonymous 2007). Other students have not had this opportunity, and they have had to "learn by doing" during their careers (Tsang and Frey 2007). In fact, Garrow et al. (1998) found that even editors usually lack formal training in the editorial process; typically, they learn by collegial interaction with a more experienced editor.

Can training sessions or workshops be used to improve the quality of reviews? If focused time is spent in a workshop or training session designed to improve reviewing abilities, the thought is that review quality will improve, in addition to the overall quality of the review process. Unfortunately, little, if any, improvement in review quality occurs as a function of such training (Callaham et al. 1998b; Callaham and Schriger 2002; Schroter et al. 2004). Two concerns were raised—if the process is voluntary, it is most likely that the below-average reviewers will not be the ones participating, leading to non-significant results (Calaham et al. 1998b). In addition, Schroter et al. (2004) suggested that those workshops they evaluated may have been too short; the effectiveness of longer duration courses should be evaluated. One relatively easy approach that may assist reviewers in learning (and it is one that reviewers like), is to provide them with the other reviews of the manuscript, as well as the editor's decision letter, with the expectation that all reviewers can gain a broader understanding of what other reviewers discover when evaluating a manuscript. This allows reviewers to compare their comments with those of others. However, no one has determined if the below-average reviewers are ones who are digesting this information or if it is just those who are already excellent.

We believe (and strongly support) involvement of graduate students in the review process. In our view, this represents a critical step in their development. In a survey (N = 20 fisheries Ph.D. students, from 13 U.S. universities), Jolley and Graeb (2007) found that most felt that they had received some training in the peer-review process, either by working with a mentor or peer group, or by working on their own manuscripts. When asked what training they would prefer, most indicated mentoring. Without some sort of structured mentoring approach, students will not be provided the tools, information, and abilities that they need to perform as a peer reviewer. Learning by doing is not an efficient approach, and training sessions/workshops do not appear to be very successful. Of course, these are certainly not approaches on which we should stake the future success of our peer-reviewed journals. As such, we present one suggestion for training graduate students as reviewers.

ONE APPROACH TO LEARNING TO REVIEW

Here, we describe a model, used in varying forms in a number of labs, in an effort to formalize a process for teaching the "how to" of peer review. Regular editorial meetings are held, during which participants (graduate students, research staff) participate in the activity of discussing the review of a manuscript. Prior to any manuscript being reviewed in such a setting, permission is requested from the editor/associate editor. If permission is granted, two volunteers are sought to serve as the reviewer and the reader for the manuscript. These individuals are responsible for reviewing the manuscript and discussing it together before the lab editorial meeting. At the lab meeting, the reviewer presents a summary of the manuscript, including a summary of its strengths and weaknesses; the reader provides any needed additional background information and helps the reviewer(s) answer questions from the group. The rest of the lab asks questions and contributes ideas to this discussion. Faculty mentors are responsible for ensuring that the discussion maintains an appropriate direction, asking relevant questions, providing a balance to the critical review process, and making sure that the group explores the value of the question being asked in the manuscript (e.g., what is the underlying ecological or management justification?). After the meeting, the reviewer(s) and reader(s) collaborate in drafting the review, and then meet with the faculty mentor to discuss the manuscript and the written review. The faculty mentor edits the review for content (is it correct, well-stated?), presentation style (is the tone positive, even if critical?), and ultimately writes the final draft of the review. It is the responsibility of the faculty mentor to make sure that the review is written as if they were the recipient of the review, a perspective that is shared with the reviewer(s) and reader(s).

Clearly, advantages and potential disadvantages exist with this sort of approach, particularly when compared with a more traditional one-on-one mentoring or a discussion of already-published papers. The one-on-one approach provides a close working interaction with the advisor or mentor (and may be quite time intensive for the mentor), but is not as likely to have a full set of ideas or questions as brought by a group. As such, the mentoring is much more labor intensive and students will not get the benefit of group discussion. When conducting a similar process with an already-published paper, students know the papers have already been through the peer review "filters," and it does not lead to a product at the end of the discussion, that is, a written evaluation with an accept/reject decision. The knowledge that the paper has already passed successfully through peer review reduces the intensity of the discussion, simply because no real-life decision is to be made. Students do not get to that last step of the process, i.e., weighing the pros and cons of a manuscript, making specific recommendations for improvement, and putting those thoughts into a constructively critical review letter to the editor with a final accept/reject/revise decision. While concerns exist that the approach described above could lead to a "feeding frenzy" of criticism, preventing this falls to the faculty mentor to provide insight from their experience, ability, and expertise, and to keep the discussion on a critical, yet constructive, path. In addition, students are presented with documents up front about the "rules" of the discussion relative to anonymity (generally most of the journals for which we review maintain reviewer anonymity) and confidentiality (i.e., protecting ideas until they are published, guarding against subconscious adoption of ideas in a manuscript), to assure that the process is professional. We have used this approach in the training of graduate students in our labs, producing students who regularly and actively participate in the peer review process as reviewers and as editorial board members, and who have provided positive feedback through time that this training environment that works.

CONCLUSIONS AND RECOMMENDATIONS

While peer review is central to our science, concerns do exist. Despite its importance, it is curious that we have not required the same rigor of study of the peer review process as we do for our science. A diverse array of literature exists, including some controlled research studies, from which we can draw conclusions

and point to some areas for future work in this area. We recommend that:

- AFS journals should evaluate the pros and cons of a double-blind approach to the peer review process in an effort to reduce the potential for bias.
- AFS should consider instituting a system for the rating of reviews (e.g., pages 169–171 in Callaham 2003) by the editorial board (editors or associate editors) for use in future possible research about the peer-review process.
- Although the evidence for the effectiveness of formal training sessions or workshops is not positive, they may provide a useful tool for introducing students to the peer review process. We suggest that our experience with a mentoring approach in a group setting for training students in the peer-review process works well for our students and research staff.

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REFERENCES

Adam, D., and **J. Knight.** 2002. Publish and be damned. Nature 419:772-776.

Alpert, J. S. 2007. Peer review: the best of the blemished. The American Journal of Medicine 120:287-288.

Amos, K. 2008. Transparency and the peer-review process. Fisheries 33(4):197-198.

Anonymous. 2007. Mentors of tomorrow. Nature 447:754.

Bachand, R. G., and **P. P. Sawallis.** 2003. Accuracy in the identification of scholarly and peer-reviewed journals and the peer-review process across disciplines. The Serials Librarian 45:39-59.

Baxt, W. G., J. F. Waeckerle, J. A. Berlin, and **M. L. Callaham.** 1998. Who reviews the reviewers? Feasibility of using a fictitious manuscript to evaluate peer reviewer performance. Annals of Emergency Medicine 32:310-317.

Bearinger, L. H. 2006. Beyond objective and balanced: writing constructive manuscript reviews. Research in Nursing and Health 29:71-73.

Benos, D. J., K. L. Kirk, and **J. E. Hall.** 2003. How to review a paper. Advances in Physiology Education 27:47-52.

Black, N., S. van Rooyen, F. Godlee, R. Smith, and **S. Evans.** 1998. What makes a good reviewer and a good review for a general medical journal? Journal of the American Medical Association 280:231-233.

Bornmann, L., R. Mutz, and **H. Daniel.** 2007. Gender differences in grant peer review: a meta-analysis. Journal of Informetrics 1:226-238.

Bourne, P. E., and **A. Korngreen.** 2006. Ten simple rules for reviewers. PLOS Computational Biology 2:973-974.

Brown, R. W. 1995. Conducting an effective manuscript review. Fisheries 20(7):40-41.

Budden, A. E., T. Tregenza, L. W. Aarssen, J. Koricheva, R. Leimu, and C. J. Lortie. 2008. Double-blind review favours increased representation of female authors. Trends in Ecology and Evolution 23:4-6.

Caelleigh, A. S., J. A. Shea, and **G. Penn.** 2001. Selection and qualities of reviewers. Academic Medicine 76:914-916.

Callaham, M. 2003. The evaluation and training of peer reviewers. Pages 164-182 *in* F. Godlee and T. Jefferson, eds. Peer review in health sciences. BMJ Books, London.

Callaham, M. L., W. G. Baxt, J. F. Waeckerle, and **R. L. Wears.** 1998a. Reliability of editors' subjective quality ratings of peer reviews of manuscripts. Journal of the American Medical Association 280:229-231.

Callaham, M. L., and **D. L. Schriger.** 2002. Effect of structured workshop training on subsequent performance of journal peer reviewers. Annals of Emergency Medicine 40:323-328.

Callaham, M. L., and J. Tercier. 2007. The relationship of previous training and experience of journal peer reviewers to subsequent review quality. PLOS Medicine 4:32-40.

Callaham, M. L., R. L. Wears, and **J. F. Waeckerle.** 1998b. Effect of attendance at a training session on peer reviewer quality and performance. Annals of Emergency Medicine 32:318-322.

Carmi, R., and **C. Koch.** 2007. Improving peer review with CARMA. Learned Publishing 20:173-176.

Ceci, S. J., and **D. Peters.** 1984. How blind is blind review? American Psychologist 39:1491-1494.

Cho, M. K., A. C. Justice, M. A. Winker, J. A. Berlin, F. Joseph, M. L. Callaham, and **R. Drummond.** 1998. Masking author identity in peer review: what factors influence masking success? Journal of the American Medical Association 280:243-245.

Cicchetti, D. V. 1980. Reliability of reviews for the American Psychologist: a biostatistical assessment of the data. American Psychologist 35:300-303.

Cooke, S. J. 2008. Truth, faith, and transparency in peer review - perspectives on the AFS peer review process. Fisheries 33(5):242-243.

Council of Science Editors. 2006. CSE's white paper on promoting integrity in scientific journal publications. CSE Editorial Policy Committee, Reston, Virginia.

Croll, P. 2007. Editorial: peer review. British Journal of Educational Studies 55:347-350.

Davidoff, F. 1998. Masking, blinding, and peer review: the blind leading the blinded. Annals of Internal Medicine 128:66-68.

Donovan, B. 1998. The truth about peer review. Learned Publishing 11:179-184.

Drotar, D. 2009. Editorial: How to write effective reviews for the Journal of Pediatric Psychology. Journal of Pediatric Psychology 34:113-117.

Earnshaw, J. J., J. R. Farndon, P. J. Guillou, C. D. Johnson, J. A. Murie, and G. D. Murray. 2000. A comparison of reports from referees chosen by authors or journal editors in the peer review process. Annals of the Royal College of Surgeons of England 82:133-135.

Epstein, W. M. 1990. Confirmational response bias among social work journals. Science, Technology, and Human Values 15:9-38.

Erren, T. C. 2007. Judging words rather than journals or authors: a reminder that peer review continues after publication. QJM An International Journal of Medicine 100:799-801.

Evans, A. T., R. A. McNutt, S. W. Fletcher, and **R. H. Fletcher.** 1993. The characteristics of peer reviewers who produce good-quality reviews. Journal of General Internal Medicine 8:422-428.

Feurer, I. D., G. J. Becker, D. Picus, E. Ramirez, M. D. Darcy, and **M. E. Hicks.** 1994. Evaluating peer reviews: pilot testing of a grading instrument. Journal of the American Medical Association 272:98-100.

Fisher, M., S. B. Friedman, and B. Strauss. 1994. The effects of blinding on acceptance of research papers by peer review. Journal of the American Medical Association 272:143-146.

Fisher, R. S., and L. E. Powers. 2004. Peerreviewed publication: a view from the inside. Epilepsia 45:889894.

Fletcher, R. H., and S. W. Fletcher. 2003. The effectiveness of journal peer review. Pages 62-75 *in* F. Godlee and T. Jefferson, eds. Peer review in health sciences. BMJ Books, London.

Friedman, D. P. 1995. Manuscript peer review at the AJR: facts, figures, and quality assessment. American Journal of Roentgenology 164:1007-1009.

Garfunkel, J. M., M. H. Ulshen, H. J. Hamrick, and **E. E. Lawson.** 1994. Effect of institutional prestige on reviewer's recommendations and editorial decisions. Journal of the American Medical Association 272:137-138.

Garrow, J., M. Butterfield, J. Marshall, and **A. Williamson.** 1998. The reported training and experience of editors in chief of specialist clinical medical journals. Journal of the American Medical Association 280:286-287.

Gilbert, J. R., E.S. Williams, and **G. D. Lundberg.** 1994. Is there a gender bias in JAMA's peer review process. Journal of the American Medical Association 272:139-142.

Glick, M. 2007. Peer review: an inexact but essential part of scientific publishing. Journal of the American Dental Association 138:568-571.

Godlee, F. 2002. Making reviewers visible: openness, accountability, and credit. Journal of the American Medical Association 287:2762-2765.

Godlee, F., and **K. Dickersin.** 2003. Bias, subjectivity, chance, and conflict of interest in editorial decisions. Pages 91-117 *in* F. Godlee and T. Jefferson, eds. Peer review in health sciences, 2nd edition. BMJ Publishing Group, London.

Godlee, F., C. R. Gale, and **C. N. Martyn.** 1998. Effect on the quality of peer review of blinding reviewers and asking them to sign their reports. Journal of the American Medical Association 280:237-240.

Goldbeck-Wood, S. 1998. What makes a good reviewer of manuscripts. British Medical Journal 316:86.

Goldsmith, L. A., E. N. Blalock, H. Bobkova, and **R. P. Hall III.** 2006. Picking your peers. Journal of Investigative Dermatology 126:1429-1430.

Goodman, S. N., J. Berlin, S. W. Fletcher, and **R. H. Fletcher.** 1994. Manuscript quality before and after peer review and editing at Annals of Internal Medicine. Annals of Internal Medicine 121:11-21.

Grant, J., S. Burden, and **G. Breen.** 1997. No evidence of sexism in peer review. Nature 390:438.

Greaves, J. S., J. Scott, M. Clarke, L. Miller, T. Hannay, A. Thomas, and **P. Campbell.** 2006. Overview: Nature's peer review trial. Nature doi:10.1038/nature05535. Available at: www.nature.com/nature/peerreview/debate/nature05535.html.

Green, S. M., and **M. L. Callaham.** 2006. Current status of peer review at Annals of Emergency Medicine. Annals of Emergency Medicine 48:304-308.

Groves, T., and **K. Abbasi.** 2004. Screening research papers by reading abstracts. British Medical Journal 329:470-471.

Gura, T. 2002. Peer review, unmasked. Nature 416:258-260.

Hammerschmidt, K., K. Reinhardt, and **J. Rolff.** 2008. Does double-blind review favor female authors? Frontiers in Ecology and the Environment 6:354.

Hansen, M. J. 2002. Reviewer rights and responsibilities. Fisheries 27(10):32-33.

Horrobin, D. F. 1990. The philosophical basis of peer review and the suppression of innovation. Journal of the American Medical Association 263:1438.

_____. 2001. Something rotten at the core of science? Trends in Pharmacological Sciences 22:51-52.

Howard, L., and **G. Wilkinson.** 1998. Peer review and editorial decision-making. British Journal of Psychiatry 173:110-113.

Jawaid, S. A., M. Jawaid, and **M. H. Jafary** 2006. Characteristics of reviewers and quality of reviews: a retrospective study of reviewers at Pakistan Journal of Medical Sciences. Pakistan Journal of Medical Sciences 22:101-06.

Jefferson, T., E. Wager, and **F. Davidoff.** 2002. Measuring the quality of editorial peer review. Journal of the American Medical Association 287:2786-2790.

Johnston, S. C., D. H. Lowenstein, D. M Ferriero, R. O. Messing, J. R. Oksenberg, and **S. L. Hauser.** 2007. Early editorial manuscript screening versus obligate peer review: a randomized trial. Annals of Neurology 61:A10-A12.

Jolley, J. C., and **B. D. S. Graeb.** 2007. Writing, publishing, and reviewing: the students' perspective. Fisheries 32(1):40-43.

Justice, A. C., M. K. Cho, M. A. Winker, J. A. Berlin, and **R. Drummond.** 1998. Does masking author identity improve peer review quality? A randomized controlled trial. Journal of the American Medical Association 280:240-242.

Katz, D. S., A. V. Proto, and **W. W. Olmstead.** 2002. Incidence and nature of unblinding by authors: our experience at two radiology journals with double-blinded peer review policies. American Journal of Radiology 179:1415-1417.

Kearney, M. H., and **M. C. Freda.** 2005. Nurse editors' views on the peer review process. Research in Nursing and Health 28:444-452.

Kemp, S. 2005. Editorial comment: agreement between reviewers of Journal of Economic Psychology submissions. Journal of Economic Psychology 26:779-784.

Kliewer, M. A., K. S. Freed, D. M. DeLong, P. J. Pickhardt, and **J. M. Provenzale.** 2005. Reviewing the reviewers: comparison of review quality and reviewer characteristics at the American Journal of Roentgenology 184:1731-1735.

Koch, D. D. 2001. Peer review: a group activity. Journal of Cataract and Refractive Surgery 27:1707.

Kronick, D. A. 1990. Peer review in 18th-century scientific journalism. Journal of the American Medical Association 263:1321-1322.

Kuyper, B. J. 1991. Bringing up scientists in the art of critiquing research. BioScience 41:248-250.

Landkroon, A. P., A. M. Euser, H. Veeken, W. Hart, and **A. J. P. M. Overbeke.** 2006. Quality assessment of reviewers' reports using a simple instrument. Obstetrics and Gynecology 108:979-985.

Lee, K. P., E. A. Boyd, J. M. Holroyd-Leduc, P. Bacchetti, and **L. A. Bero.** 2006. Predictors of publication: characteristics of submitted manuscripts associated with acceptance at major biomedical journals. Medical Journal of Australia 184:621-626.

Loonen, M. P. J., J. J.Hage, and **M. Kon.** 2005. Who benefits from peer review? An analysis of the outcome of 100 requests for review by Plastic and Reconstructive Surgery. Plastic and Reconstructive Surgery 116:1461-1472.

Lortie, C. J., L. W. Aarssen, A. E Budden, J. K. Koricheva, R. Leimu, and T. Tregenza. 2007. Publication bias and merit in ecology. Oikos 116:1247-1253.

Mahoney, M. J. 1977. Publication prejudices: an experimental study of confirmatory bias in the peer review system. Cognitive Therapy and Research 1:161-175.

Marsh, H. W., and S. Ball. 1981. Interjudgemental reliability of reviews for the Journal of Educational Psychology. Journal of Educational Psychology 73:872-880.

McCoy, E. D. 1993. Review peering: a look at the ESA's peer review process. Bulletin of Ecological Society of America 74:232-236.

McCutchen, C. W. 1991. Peer review: treacherous servant, disastrous master. Technology Review 94:29-40.

McNutt, R. A., A. T. Evans, R. H. Fletcher, and **S. W. Fletcher.** 1990. The effects of blinding on the quality of peer-review- a randomized trial. Journal of the American Medical Association 263:1371-1376.

Michels, R. 1995. Peer review. International Journal of Psycho-Analysis 76:217-221.

Moher, D., and **A. R. Jadad.** 2003. How to peer review a manuscript. Pages 183-190 *in* F. Godlee and T. Jefferson, eds. Peer review in health sciences. BMJ Books, London.

Mulligan, A. 2005. Is peer review in crisis? Oral Oncology 41:135-141.

Northcraft, G. 2001. From the editors. Academy of Management Journal 44:1079-1080.

Peters, D. P., and S. J. Ceci. 1982. Peer-review practices of psychological journals: the fate of published articles, submitted again. The Behavioral and Brain Sciences 5:187-255.

Plug, C. 1993. The reliability of manuscript evaluation for the South African Journal of Psychology. South African Journal of Psychology 23:43-48.

Poschl, U., K. S. Carslaw, T. Koop, R. Sander, W. T. Sturges, J. P. D. Abbatt, J. T. Jayne, and **D. R. Worsnop.** 2004. Scientific quality assurance by interactive peer review and public discussion. Abstracts of Papers of the American Chemical Society 228: U357-U357 017-CINF Part 1.

Provenzale, J. M., and **R. J. Stanley.** 2005. A systematic guide to reviewing a manuscript. American Journal of Roentgenology 185:848-854.

Publishing Research Consortium. 2008. Peer review in scholarly journals. Mark Ware Consulting Ltd., Bristol, UK. Available at: www.publishingresearch.net/PeerReview.htm.

Raelin, J. A. 2008. Refereeing the game of peer review. Academy of Management Learning and Education 7:124-129.

Raveendran, R. 2006. Rejecting manuscripts without external review. Indian Journal of Pharmacology 38.5 (September-October 2006).

Regehr, G., and **G. Bordage.** 2006. To blind or not to blind? What authors and reviewers prefer. Medical Education 40:832-839.

Relman, A. S. 1990. Peer review in scientific journals—what good is it? Western Journal of Medicine 153:520-522.

Rennie, D. 1998. Freedom and responsibility in medical publication. Journal of the American Medical Association 280:300-302.

_____. 2003a. Editorial peer review: its development and rationale. Pages 1-13 *in* F. Godlee and T. Jefferson, eds. Peer review in health sciences. BMJ Books, London.

_____. 2003b. Innovation and peer review. Pages 76-90 *in* F. Godlee and T. Jefferson, eds. Peer review in health sciences. BMJ Books, London.

Rivara, F. P., P. Cummings, S. Ringold, A. B. Bergman, A. Joffe, and **D. A. Christakis.** 2007. A comparison of reviewers selected by editors and reviewers suggested by authors. Journal of Pediatrics 151:202-205.

Roberts, J. C., R. H. Fletcher, and **S. W. Fletcher.** 1994. Effects of peer review and editing on the readability of articles published in Annals of Internal Medicine. Journal of the American Medical Association 272:119-121.

Robin, E. D., and **C. M. Burke.** 1987. Peer review in medical journals. Chest 91:252-255.

Rosenzweig, M. L., J. I. Davis, and **J. H. Brown.** 1988. How to write an influential review. Bulletin of the Ecological Society of America 69:152-155.

Rothwell, P. M., and **C. N. Martyn.** 2000. Reproducibility of peer review in clinical neuroscience: is agreement between reviewers any greater than would be expected by chance alone? Brain 123:1964-1969.

Schroter, S., N. Black, S. Evans, J. Carpenter, F. Godlee, and **R. Smith.** 2004. Effects of training on quality of peer review: randomised controlled trial. British Medical Journal 328:673-677.

Schroter, S., L. Tite, A. Hutchings, and **N. Black.** 2006. Differences in review quality and recommendations for publication between peer

reviewers suggested by authors or by editors. Journal of the American Medical Association 295:314-317.

Scott, W. A. 1974. Interreferee agreement on some characteristics of manuscripts submitted to the Journal of Personality and Social Psychology. American Psychologist 29:698-702.

Siegelman, S. S. 1991. Assassins and zealots: variations in peer review. Radiology 178:637-642.

Smit, C. 2006. Peer review: time for a change? BioScience 56:712-713.

Smith, R. 2006. Peer review: a flawed process at the heart of science and journals. Journal of the Royal Society of Medicine 99:178-182.

Stensrud, D. J., and **H. E. Brooks.** 2005. The future of peer review? Weather and Forecasting 20:825-826

Stossel, T. P. 1985. Reviewers status and review quality: experience of the journal of clinical investigation. The New England Journal of Medicine 312:658-659.

Tite, L., and **S. Schroter.** 2007. Why do peer reviewers decline to review? A survey. Journal of Epidemiology and Community Health 61:9-12.

Tregenza, T. 2002. Gender bias in the refereeing process? Trends in Ecology and Evolution 17:349-350.

Tsang, E. W. K., and B. S. Frey. 2007. The as-is journal review process: let authors own their ideas. Academy of Management Learning and Education 6:128-136.

van Rooyen, S. 2001. The evaluation of peer-review quality. Learned Publishing 14:85-91.

van Rooyen, S., N. Black, and **F. Godlee.** 1999a. Development of the review quality instrument (RQI) for assessing peer reviews of manuscripts. Journal of Clinical Epidemiology 7:625-629.

van Rooyen, S., F. Godlee, S. Evans, N. Black, and **R. Smith.** 1999b. Effect of open peer review on quality of reviews and on reviewers' recommendations: a randomised trial. British Medical Journal 318:23-27.

_____. 1998. Effect of blinding and unmasking on the quality of peer review: a randomized trial. Journal of the American Medical Association 280:234-237.

Wager, E., E. C. Parkin, and **P. S. Tamber.** 2006. Are reviewers suggested by authors as good as those chosen by editors? Results of a rater-blinded retrospective study. BioMed Central Medicine 4:13 doi10.1186/1741-7015-4-13.

Waldrop, M. W. 2008. What is Edit This? Scientific American website at www.sciam.com/article.cfm?id=science-2-point-0-great-new-tool-or-great-risk.

Walsh, E., M. Rooney, L. Appleby, and **G. Wilkinson.** 2000. Open peer review: a randomised controlled trial. British Journal of Psychiatry 176:47-51.

Waser, N. M., M. V., Price, and **R. K. Grosberg.** 1992. Writing an effective manuscript review. BioScience 42:621-623.

Webb, T. J., B. O'Hara, and **R. P. Freckleton.** 2008. Does double-blind review benefit female authors? Trends in Ecology and Evolution 23:351-353.

Weller, A. C. 1991. Potential bias in editorial peer review: a study of U.S. medical journals. The Serials Librarian 19:95-103.

_____. 1996. Editorial peer review: a comparison of authors publishing in two groups of U.S. medical journals. Bulletin of the Medical Library Association 84:359-366.

Wenneras, C., and **A. Wold.** 1997. Nepotism and sexism in peer-review. Nature 387:341-343.

Wets, K., D. Weedon, and **J. Velterop.** 2003. Post-publication filtering and evaluation: faculty of 1000. Learned Publishing 16:249-258.

Whittaker, R. J. 2008. Journal review and gender equality: a critical comment on Budden et al. Trends in Ecology and Evolution 23:478-479.