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Authors: Steinman, Alan D., Silver, Pamela, Fisher, Stuart, and Meyer, Judy L.

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The *J-NABS* 25th anniversary issue: reflecting on the past, synthesizing the present, and projecting into the future

Alan D. Steinman[1,5], **Pamela Silver**[2,6], **Stuart Fisher**[3,7], AND **Judy L. Meyer**[4,8]

[1] *Annis Water Resources Institute, Grand Valley State University, 740 W. Shoreline Dr., Muskegon, Michigan 49441 USA*
[2] *School of Science, Penn State Erie, Erie, Pennsylvania 16563 USA*
[3] *School of Life Science, Arizona State University, Tempe, Arizona 85287-4501 USA*
[4] *Odum School of Ecology, University of Georgia, Athens, Georgia 30602 USA*

Abstract. The year 2010 marks the 25th anniversary of publication of the *Journal of the North American Benthological Society* (*J-NABS*). To highlight the occasion, we solicited 18 contributions, classified into: 1) physical environment, 2) interface of chemistry and biology, 3) biota, and 4) human factor, to review how subdisciplines within the general field of benthology have changed. We identified 7 major themes across the 18 contributions. First, articles dealing with biota were published with the greatest number in *J-NABS* over the past 25 y, but an increasing number of papers address the human factor and the chemical/biological interface. A 2nd theme was the value of special issues and series, which have resulted in greater visibility and attention for selected topics. Three of the 7 themes could be loosely classified as focusing on emerging or future trends: 3) the role of new technologies and methods in advancing benthic science, 4) the growing importance of multidisciplinary approaches to tackling problems, and 5) convergence by different disciplines on key research topics, such as trait-based indices, spatial heterogeneity, and nonlinear behavior of ecosystems. The 6th theme was the apparent insularity within stream ecology, which could be reduced by increased borrowing from and contributing to general ecological theory. Last, many contributions trumpeted a call to action, calling on practitioners to put benthic science into practice. Directions identified for potentially fruitful future research included new technologies; multidisciplinary research; and emerging stressors, such as pharmaceuticals, climate change, and urban runoff. We conclude by recommending a transition to more solution-based research and by recognizing that the volume of new information being generated creates both opportunities and challenges for the future.

Key words: *J-NABS*, multidisciplinary, nonlinearity, spatial heterogeneity, technological advance, trait-based indices, environmental problem solving.

Synthesizing 25 y of benthological science is not a trivial task; close examination of the 18 reviews in this issue clearly reflect this perception. Although the subjects considered range in scale from molecules to landscapes, our intention was never to capture the full breadth of benthological research; rather, our goal was to characterize broadly the topics that have been addressed consistently in the last 25 volumes of *J-NABS* (**Silver et al. 2010**[9]). Thus, several areas that have seen a recent surge of research interest, such as urban streams and invasive species, did not receive separate reviews. Moreover, other traditional research areas for benthologists, such as toxicology and nonbacterial microbes (meiofauna, protozoa, fungi), were not addressed individually, although Stanley et al. (**2010;** disturbance) and Findlay (**2010;** microbial ecology) touch on these topics. Several taxonomic groups, e.g., freshwater mollusks, crayfish, and aquatic insects, appear frequently in *J-NABS* papers. These groups also were not reviewed separately, but they are mentioned in several reviews (especially **Holomuzki et al. 2010**, **Holzenthal et al. 2010, Resh and Rosenberg 2010, Strayer and Dudgeon 2010**). Our objectives in this synthesis were to explore common themes arising in these reviews, and to

[5] E-mail addresses: steinmaa@gvsu.edu
[6] psb3@psu.edu
[7] s.fisher@asu.edu
[8] judymeye@gmail.com

[9] Boldface indicates paper was published in *J-NABS*

TABLE 1. Top 10 most cited papers published in *J-NABS* based on the Institute for Scientific Information (ISI) Web of Knowledge (accessed 5 November 2009). Asterisk indicates the volume was a "special issue" or "special series" (see text).

Year	Volume(issue)	Paper title	Author(s)	Number of citations
1988	7(4)*	The role of disturbance in stream ecology	V. H. Resh, A. V. Brown, A. P. Covich, M. E. Gurtz, H. W. Li, G. W. Minshall, S. R. Reice, A. L. Sheldon, J. B. Wallace, R. Wissmar	623
1989	8(1)	The patch dynamics concept of stream community ecology	C. R. Townsend	359
1988	7(4)*	Hydraulic stream ecology: observed patterns and potential applications	B. Statzner, J. A. Gore, V. H. Resh	320
1997	16(2)*	Landscape filters and species traits: towards mechanistic understanding and prediction in stream ecology	N. L. Poff	311
1989	8(1)	The four-dimensional nature of lotic ecosystems	J. V. Ward	284
1995	14(4)*	Contributions of benthic algae to lake food webs as revealed by stable isotope analysis	R. E. Hecky, R. H. Hesslein	236
1988	7(4)*	Patch dynamics in lotic systems: the stream as a mosaic	C. M. Pringle, R. J. Naiman, G. Bretschko, J. R. Karr, M. W. Oswood, J. R. Webster, R. L. Welcomme, M. J. Winterbourn	235
1993	12(1)*	An ecosystem perspective of alluvial rivers: connectivity and the hyporheic corridor	J. A. Stanford, J. V. Ward	231
1999	18(3)	Length–mass relationships for freshwater macroinvertebrates in North America with particular reference to the southeastern United States	A. C. Benke, A. D. Huryn, L. A. Smock, J. B. Wallace	227
1988	7(4)*	Stream ecosystem theory: a global perspective	G. W. Minshall	217

speculate on promising future directions for the field of benthology.

Reflecting on the past

We used the Institute for Scientific Information (ISI) Web of Knowledge to identify the 10 most cited papers in *J-NABS* (Table 1). As might be expected for highly-cited papers, they are mostly broad in scope and represent an intellectual advance in the understanding of stream ecology. Two of the 10 papers (**Hecky and Hesslein 1995, Benke et al. 1999**) stand out because of their methodological focus.

By far, the most cited paper published in *J-NABS* is Resh et al. (**1988**), dealing with disturbance (Table 1). This high citation rate denotes the importance of disturbance in stream ecology, which is reinforced by its prominence in 4 other top-10 cited papers (**Minshall 1988, Pringle at al. 1988, Statzner et al. 1988, Townsend 1989**; Table 1). However, Resh et al. (**1988**) had other features that accounted for its high citation rate: the subject matter was placed in the broader context of general ecological theory; disturbance was addressed at multiple spatial and temporal scales; cross-ecosystem comparisons were used to evaluate disturbance; biotic and physical disciplines were linked; mechanistic explanations were provided for observed and predicted patterns; and disturbance was examined from multiple perspectives (observational and empirical studies, basic and applied research, biotic and geomorphic influences). These features are common to other highly cited *J-NABS* papers. For example, Poff (**1997**) developed a conceptual framework for understanding species distribution and abundance in streams. His approach of using filters to screen hierarchically which species are likely to be found in a habitat also incorporated multiple spatial scales, linked biotic and physical factors, provided a mechanistic framework for understanding patterns, meshed stream theory with general ecological theory on geographic patterns of species distribution, and was relevant to both basic and applied scientists.

Another topic common to several of the top-10 cited papers was spatial heterogeneity. The papers by Minshall (**1988**), Pringle et al. (**1988**), Statzner et al. (**1988**), Townsend (**1989**), Ward (**1989**), and Stanford and Ward (**1999**) (Table 1) identify the importance of this issue, and how a holistic understanding of stream ecosystems is incomplete without an accounting of this factor. These authors all acknowledged the importance of spatial heterogeneity in understanding stream systems, and that this heterogeneity exists at multiple scales. Our continuing challenge lies in treating this heterogeneous distribution of resources, organisms, and geomorphic units that exist in stream ecosystems as information rather than noise.

The 2 highly cited papers with a strong focus on methods (**Hecky and Hesslein 1995, Benke et al. 1999**) both contained data-rich tables of high potential value to readers. Hecky and Hesslein (**1995**) used stable isotopes to highlight the importance of benthic metabolism to support food webs. The high citation rate of this paper can be attributed to the increasing use of stable isotope analysis, their cross-ecosystem comparisons, and the growing interest in benthic–pelagic coupling in aquatic ecosystems. Benke et al. (**1999**) compiled and analyzed length–mass regressions for North American invertebrates; these relationships provided critical baseline information for ecologists working on macroinvertebrates.

Common themes

We searched for common and emerging themes among the 18 contributions. In some cases, themes were specific to certain subdisciplines, whereas in others, they transcended the entire field. Altogether, 7 major themes were extracted from the contributions.

Theme 1: Publication trends among major categories.— We conducted an analysis of the papers published in *J-NABS* between 1986 (issue 5[1]) and 2009 (issue 28[2]) to assess publication trends in subject matter. To be consistent with the organization of this issue, we assigned papers to 1 of the 5 major categories: physical environment, interface of chemistry and biology, biota, human factor, and synthesis. We grouped papers into 5-y increments. We recognize that, in many cases, papers could have been assigned to multiple categories. However, we used the category assignments for this issue as a guideline (e.g., if the major focus of the paper was nutrient uptake, even though autotrophic biomass was estimated in the study, we assigned it to interface of chemistry and biology, not biota). We attempted to be as consistent as possible in these categorical placements.

Papers dealing with biota (i.e., taxonomy and systematics, microbial ecology, primary producers, invertebrate autecology, biotic interactions, ecosystem linkages, and secondary production) clearly dominated throughout all 5-y periods except 1996–2000 (Fig. 1). In contrast, the number of papers addressing the physical environment has remained relatively steady over time, except for a small peak during 1996–2000, which is attributable, at least in part, to issue 16(1), which contained a series on heterogeneity in streams, and to issue 19(3), which dealt with landscape classifications (Table 2). Other patterns include increases over time in human factor and biological/chemical interface papers (Fig. 1). The high number of papers focusing on anthropogenic influences was a function of 2 special issues: 24(3) on urbanization and stream ecology and 27(4) on regional assessments of stream ecological condition, as well as a growing appreciation of the need to understand the habitat in which humans live and that they influence (Millennium Ecosystem Assessment 2005). The slow but steady rise in papers addressing the interface of biology and chemistry reflects growing interest in stream ecosystem function (**Mulholland and Webster 2010, Tank et al. 2010**). To some degree, this increase has been at the expense of traditional taxonomic and systematics papers (**Holzenthal et al. 2010**); however, this field might be on the cusp of a resurgence given the growing concern over declining biodiversity (**Strayer and Dudgeon 2010**) and the associated need for increased taxonomic expertise.

The trend toward more publications in the area of human influences certainly is not unique to *J-NABS*. Increasing attention given to global threats and a growing appreciation of the coupling between human and natural systems and its attendant complexities are evident in the literature (Foley et al. 2005, Liu et al. 2007). This trend is expected to continue because of the pressures placed on water resources (Baron et al. 2002, Allan 2004) (see *Theme 7: A call to action* and Future Directions below).

Theme 2: Value of special issues and series in J-NABS.— *J-NABS* has frequently published proceedings from workshops, symposia, groups of papers on a common theme, and special sessions in the form of "special issues" or "special series," which provide timely overviews of the current state of thinking in freshwater benthological science (Table 2). Special issues present topics from many perspectives and provide a convenient forum for readers interested in the subject matter. Well-conceived and edited groups of papers can help advance a field by clarifying concepts, establishing definitions, and charting future directions.

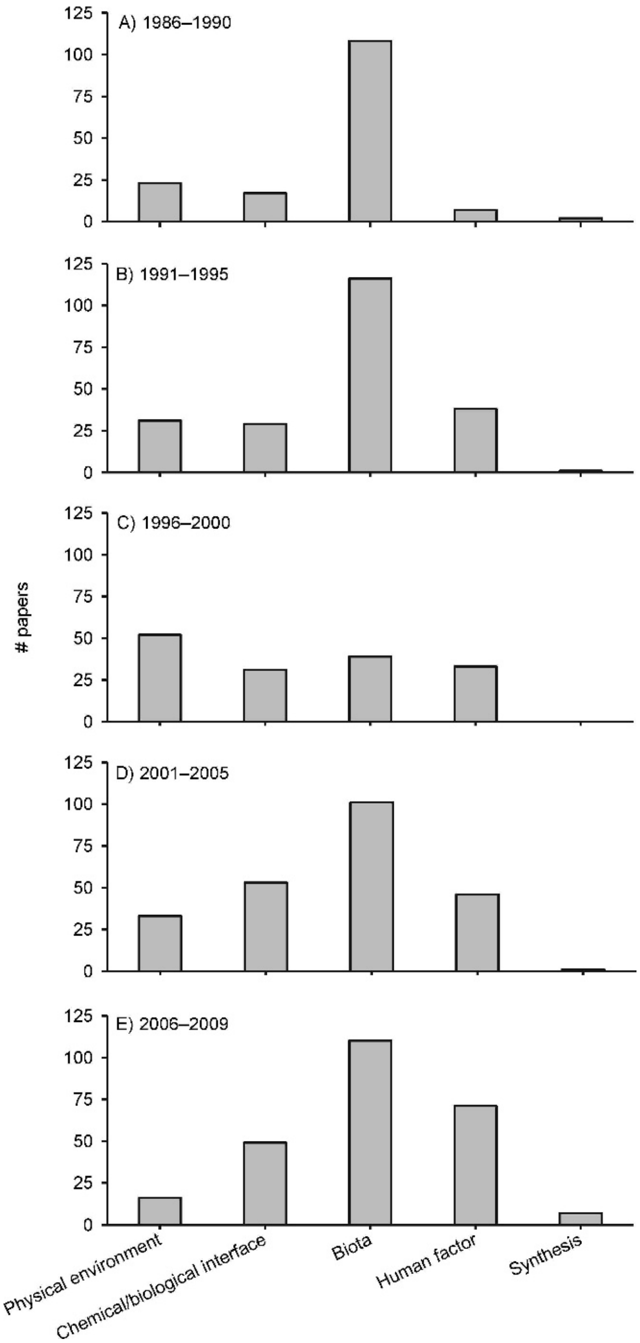

FIG. 1. Number of articles published in *J-NABS* in 1986–1990 (A), 1991–1995 (B), 1996–2000 (C), 2001–2005 (D), and 2006–2009 (volume 28[2]) (E). Articles were classified by broad theme including the physical environment, interface of biology and chemistry, biota, human factor, and synthesis.

The importance of these special series to the scientific community is difficult to assess because citation indices do not capture fully the influence they might have had on current thinking or future research efforts. Nonetheless, 7 of the 10 most-cited papers published in *J-NABS* were associated with special issues (Table 1). Indeed, the authors of papers in this anniversary issue repeatedly refer to the special issues or papers published in them as key events in the development of their subdisciplines (e.g., **Boulton et al. 2010**, **Stanley et al. 2010, Tank et al. 2010**). Their impact could be manifested in 2 ways: 1) by triggering an interest in a subject area, such as tropical streams or the hyporheic zone that had received relatively little attention prior to that point in time or 2) by covering a subject area, such as organic matter budgets or landscape classifications, that had reached a state of relative maturity and was ready for critical analysis and synthesis to help determine next steps (Table 2). Increased emphasis on the need to apply our science to environmental problems might be a primary reason why 4 of the last 6 special series have focused on application of research: regional assessments of stream ecological condition, freshwater mollusk conservation, source-water monitoring, and urbanization and stream ecology (Table 2).

Theme 3: Role of new technology and methods.—Many of the authors in this issue noted that advances in their field were made possible by new methods of measurement and analysis. Method development always will be an important element in moving science forward, but it is important that the application of new technology be carefully considered and deemed appropriate to the questions at hand. Some of the new tools identified in the papers in this issue include advanced remote sensing imagery and new-generation geographical information system (GIS) algorithms (**Johnson and Host 2010**), continuous monitoring probes (**Mulholland and Webster 2010**), and web-based tools and databases for taxonomy and systematics studies (**Holzenthal et al. 2010**).

Theme 4: Multidisciplinary approach.—A recurring theme among the contributions was the need for multidisciplinary (viewing a problem from different disciplinary viewpoints) or transdisciplinary (crossing of boundaries between scientific and nonscientific communities; Schoot Uiterkamp and Vlek 2007) approaches to research problems. For example, Poole (**2010**) called for an integration of hydrology, geomorphology, hydrogeology, and ecology; Stanley et al. (**2010**) suggested that our ability to understand disturbance and place it in the context of river restoration would be greatly improved if physical, natural, and social scientists worked in concert; Benke and Huryn (**2010**) identified ecological questions, ranging from landscape ecology to metabolic theory, to which benthic invertebrate production is now being applied; and Lamberti et al. (**2010**) called for more interdisciplinary research to address ecological linkages in benthic systems. Of course, recommending

TABLE 2. List of special issues, series, and workshop proceedings published in *J-NABS*, with identifying information.

Year	Volume(issue)	Issue title	Organizers	Number of papers in series
1988	7(4)	Community structure and function in temperate and tropical streams: proceedings of a symposium	J. A. Stanford, A. P. Covich	13
1993	12(1)	Perspectives on the hyporheic zone	H. M. Valett, C. C. Hakenkamp, A. J. Boulton	8
1993	12(2)	Perspectives on freshwater conservation	C. M. Pringle, N. G. Aumen	10
1994	13(2)	Symposium: nonvisual cues in antipredator behaviour	J. M. Culp, T. A. Crowl	7
1995	14(1)	Research in tropical streams and rivers	J. K. Jackson, B. W. Sweeney	15
1995	14(4)	Tropical and subtropical lakes: processes, organisms, and some northern comparisons	S. MacIntyre, J. M. Melack	4
1996	15(4)	Temporary aquatic habitats	J. W. Feminella	5
1996	16(1)	Stream organic matter budgets	J. R. Webster, J. L. Meyer	25
1996	16(1)	Heterogeneity in streams	M. A. Palmer, N. L. Poff	10
1997	16(2)	New concepts in stream ecology: proceedings of a symposium	P. Koetsier, J V. McArthur	11
1999	18(1)	Freshwater mollusks and water quality	D. L. Strayer	4
2000	19(3)	Landscape classifications: aquatic biota and bioassessments	C. P. Hawkins, R. H. Norris	14
2001	20(2)	Ecology and management of large rivers	T. B. Mihuc, J. W. Feminella	5
2005	24(3)	Urbanization and stream ecology	J. W. Feminella, C. J. Walsh	10
2006	25(1)	New vistas in Neotropical streams	K. M. Wantzen, A. Ramírez, K. O. Winemiller	15
2006	25(4)	Source-water monitoring: combining basic and applied research	J. G. Blaine, B. W. Sweeney, D. B. Arscott	10
2007	27(2)	Directions in freshwater mollusk conservation	A. D. Christian, J. L. Harris	11
2007	27(4)	Regional assessments of stream ecological condition: scientific challenges associated with the USA's national Wadeable Stream Assessment	C. P. Hawkins, S. G. Paulsen, J. Van Sickle, L. L. Yuan	16
2009	28(2)	Are tropical streams really different?	L. Boyero, A. Ramírez, D. Dudgeon, R. G. Pearson	10
2009	28(4)	Second symposium on urbanization and stream ecology	A. H. Roy, A. H. Purcell, C. J. Walsh, S. J. Wenger	13

interdisciplinary research is far different than being able to implement it. As Brewer (1999) noted, "the world has problems but universities have departments." Hence, individuals engaged in successful multidisciplinary projects often show certain characteristics, such as an interest in practical problems, strong motivation to develop a common multidisciplinary understanding, tolerance and the ability to handle misunderstandings and to explain one's own viewpoint, and willingness to listen carefully to experts from other disciplines (Weingart and Stehr 2000).

Theme 5: Convergence on key research topics.—Several research areas were identified that are receiving attention from different subdisciplines within benthology. These areas included trait-based indices, spatial heterogeneity, and nonlinear responses of ecosystems. Research on species traits has a long history (**Resh and Rosenberg 2010**), but the papers of Townsend and Hildrew (1994), Poff (**1997**), and Statzner et al. (1997) helped influence adoption of trait-based indices for a variety of applications in freshwater systems. Dolédec and Statzner (**2010**) provided an overview of application of trait-based indices to assessing ecosystem processes and note that, despite the advantages of this approach for bioassessment (also noted by **Resh and Rosenberg 2010**), its use currently is limited by the lack of consistent trait information, especially for rare or understudied taxa. Winemiller et al. (**2010**) also noted the importance of species traits to understanding biotic responses to patch disturbance. These traits have clear implications for biotic interactions (**Holomuzki et al. 2010**). Last, Holzenthal et al. (**2010**) addressed the role of species traits in comparative phylogenetic approaches, and Resh and Rosenberg (**2010**) described how species traits can be a useful component of life-history studies.

A 2nd research area that received considerable attention was spatial heterogeneity. Winemiller et al. (**2010**) addressed this topic explicitly. They described how both temporal and spatial variation influence patterns and processes in streams at virtually all scales, and how a better understanding of the effect of this variability could improve the rigor of bioassessment (**Dolédec and Statzner 2010**) and benchmark assessments (**Hawkins et al. 2010**). Spatial heterogeneity also was a major theme in the review by Johnson and Host (**2010**). At coarse scales, heterogeneity helps characterize landscapes and has profound effects on ecosystem structure and function. At fine scales, Holomuzki et al. (**2010**) noted that spatial heterogeneity can strongly influence biotic interactions, such as facilitation and interference, and Boulton et al. (**2010**) described the implications of the heterogeneous distribution of surface–subsurface exchange patches for stream structure and function.

The 3rd research area referenced multiple times in reviews was nonlinear responses. Stanley et al. (**2010**) demonstrated that disturbance in streams can result in nonlinear responses and might cause regime shifts, similar to those observed in other ecosystems (Scheffer et al. 2001). Winemiller et al. (**2010**) noted that the use of nonlinear models could be of value in examining the effects of patchily distributed disturbances and nutrient inputs. In addition, Holomuzki et al. (**2010**) pointed out that biotic interactions often elicit nonlinear responses; Boulton et al. (**2010**) noted that linkages across hyporheic habitat patches are often nonlinear; and Larned (**2010**) identified several nonlinear responses exhibited by periphyton communities.

Interest in trait-based indices, spatial heterogeneity, and nonlinear responses is certainly not unique to benthology. These topics have received considerable attention in ecology in recent years, but the convergence of interest in them from different subdisciplines within stream ecology and benthology suggests these research areas may serve as "hubs for innovation" in the future (Leifer et al. 2001). The topics of spatial heterogeneity and nonlinear responses force us to recognize that ecosystems are dynamic entities with potentially complex behaviors. These reviews addressing heterogeneity and nonlinearity reinforce the message that virtually every aspect of stream ecology is characterized, to some extent, by variability. Our conceptual frameworks, computational models, and empirical studies must incorporate these elements if we are to gain a more accurate understanding of how benthic ecosystems operate.

Theme 6: Is benthic (stream) ecology parochial?—One implicit theme in many reviews in this issue was the apparent insularity of stream ecology as a field of study. Is stream ecology a self-reinforcing discipline? One might draw that conclusion from Table 1, as 8 of the 10 most-cited papers in *J-NABS* included "stream", "lotic", or "river" in the title. Ironically, Minshall (**1988**) wrote over 20 y ago that the time was ripe to for stream ecologists to free themselves from the past influences of ecology and evolution, and to develop new directions specific to stream ecology.

Stream ecosystems clearly have unique characteristics, such as unidirectional connectivity associated with downstream flow (Pringle 2001), which probably accounts for some self-reinforcement. However, several reviews in this issue highlighted that streams should be viewed in a broader context than simply within-channel structure and function (**Johnson and Host 2010, Lamberti et al. 2010, Poole 2010**). Rather than focusing on unique attributes, perhaps a more rewarding approach would be to focus on the commonalities that exist among different ecosystems. Comparing ecological structures and processes in streams to other ecosystems can lead to new insights. Theoretical advances from other systems permeated the papers on disturbance (**Stanley et al. 2010**) and patch dynamics (**Winemiller et al. 2010**), but comparisons among systems were rare with the exception of Benke and Huryn (**2010**). Stream ecologists have led other ecological disciplines in the development and application of biotic indices to assess ecosystem condition (**Dolédec and Statzner 2010, Hawkins et al. 2010**) and in quantifying secondary production (**Benke and Huryn 2010**).

Many of the subject areas addressed in this issue are near or at the forefront of critical issues in the broader field of ecology, including disturbance (**Stanley et al. 2010**), environmental heterogeneity (**Winemiller et al. 2010**), trophic interactions (**Holomuzki et al. 2010**), ecosystem linkages (**Lamberti et al. 2010**), and conservation (**Strayer and Dudgeon 2010**). Yet, as Strayer and Dudgeon (**2010**) noted, conservation-oriented papers published in *J-NABS* often consider specialized technical issues rather than general, theoretical, or conceptual problems; this tendency might reflect a submission bias rather than a publication bias. Some benthologists perceive that stream- or benthic-specific theory has not received the attention it deserves in the wider arena of science. If true, then a valid question is whether the North American Benthological Society (NABS) or *J-NABS* should take a more active role in addressing this disparity.

Theme 7: A call to action.—Several authors in this issue assert that aquatic scientists should be putting our science into practice to help solve the global water crisis (Vörösmarty 2000, Baron et al. 2002). Many of the founders of NABS were applied scientists (Mackay 2005), and the need to encourage benthologists to publish applied research helped catalyze the formation of *BRIDGES* (**Aumen et al. 2010**). Nonetheless, the perception persists that many ecologists currently are not connecting their research to societal needs. Strayer and Dudgeon (**2010**) called for a higher level of engagement in conservation initiatives by aquatic scientists and recommended that we focus on doing work that is not just useful but that actually is used by society. This call was echoed by Stanley et al. (**2010**), who recommended that we "operationalize" our understanding of disturbance and begin applying our knowledge toward more informed river management and restoration decisions. In addition, several authors called for engagement of citizen scientists, whose volunteering efforts could bolster areas such as taxonomy and life-history research (**Holzenthal et al. 2010, Resh and Rosenberg 2010**). Citizen volunteering for water-quality monitoring also has received attention at the US federal level (e.g., http://www.epa.gov/owow/monitoring/volunteer/).

Projecting into the future

Each of the contributors to this special issue identified future research directions. Several directions transcend traditional subject areas and thus, have the potential to transform the field of benthology.

New technologies and multidisciplinary research have the potential to revolutionize our understanding of benthic systems. New technologies, such as remote observational systems with continuous monitoring, nanomaterials, and bioinformatics, can help provide answers to previously intractable questions or might offer new data with which to address old questions. Research that crosses traditional disciplines has great potential to move benthological science forward. Some of these cross-discipline areas include linking the patterns, rates, and magnitudes of physical connectivity to ecosystem processes (**Johnson and Host 2010, Poole 2010**); collaborating with population geneticists and parasitologists on trophic interaction studies (**Holomuzki et al. 2010**); and integrating our understanding of physical processes with the hyporheic zone (**Boulton et al. 2010**), biochemical reactions (**Mulholland and Webster 2010, Tank et al. 2010**), and river restoration (**Stanley et al. 2010**).

Certain fields of study already are experiencing rapid growth in benthology or appear ripe for future growth. These fields include but certainly are not limited to the influence of stressors, such as climate change, urban runoff, and microconstituents (pharmaceuticals and personal care products), on water resources. Larned (**2010**) recommended examining single stressors to develop mechanistic understanding, whereas other authors noted that our experiments should examine multiple stressors to better mimic the natural world (**Stanley et al. 2010, Winemiller et al. 2010**). Winemiller et al. (**2010**) also highlighted the need to examine systems at multiple spatial and temporal scales. Real-world application of research findings requires that experiments be conducted at broad spatial and temporal scales (Dahm et al. 1995, Steinman et al. 2002), and that a linkage be made between this heterogeneity and a mechanistic understanding of system structure and function (**Poff 1997,** Steinman and Denning 2005).

In addition to applying new technologies and investigating new fields of study, our philosophical approach to answering questions might be an area of future conversation. Creutzburg and Hawkins (**2008**) observed that benthological research might be more likely to advance our field if the research emphasis shifted from observational and descriptive studies to formal hypothesis testing and development of theory. This sentiment is echoed by Winemiller et al. (**2010**), who note that most of the studies published in *J-NABS* are empirical in nature.

We must move beyond identifying and cataloguing problems ("purveyor of doom syndrome") to proposing solutions (Gleick 2003, Jury and Vaux 2005). This type of science must be transdisciplinary and participatory, and must view nature in a multidimensional framework. Ultimately, our environmental problems will not be solved unless we also view them as economic, social, and political problems. Integrating our benthological research into this broader context will be neither easy nor quick, but is essential if we hope to enhance and preserve our water resources.

Last, let us not forget how far the benthic sciences have come in the past 25 y. The volume of information now being produced in our field is nothing short of overwhelming. Our ecological knowledge of streams and benthos has grown tremendously since the first issue of *J-NABS* was published. It is our hope that these reviews will provide a framework upon which the students of the future, as well as the ones of today, can construct a solid intellectual edifice, and transform this information flow into creative and relevant research questions and solutions.

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