Volume 18 (2) June 2009

LIMNOLOGY AND OCEANOGRAPHY

BULLETIN

ASLO

Advancing the science of limnology and oceanography

ABOUT THE COVER IMAGE

About the cover image: James G. Needham with limnology students ca. 1925. The student diversity, both gender and ethnic, in the group is striking. At least eleven women obtained advanced degrees (four M.S. and seven Ph.D.) working with Needham. *Photo from the Rare and Manuscript Collection, Cornell University Library.*

ARTICLES

FEATURES

MEETING HIGHLIGHTS

ASLO NEWS

BOOK REVIEWS

The Limnology and Oceanography

Bulletin

The American Society of Limnology and Oceanography is a membership-driven scientific society (501(c)(3)) that promotes the interests of limnology (the study of inland waters), oceanography and related aquatic science disciplines by fostering the exchange of information and furthering investigations through research and education. ASLO also strives to link knowledge in the aquatic sciences to the identification and solution of problems generated by human interactions with the environment.

Editors: Adrienne Froelich Sponberg, Ph.D., P.O. Box 8785, Silver Spring, MD, 20907, USA and John Dolan, Microbial Ecology, Laboratoire d'Océanographie de Villefranche, CNRS & Universite, Paris VI, Station Zoologique, B.P. 28, F-06230 Villefranche-Sur-Mer, France

E-mail: bulletin-editors@aslo.org

ASLO Business Manager:
Helen Schneider Lemay, ASLO Business Office, Waco, TX, 76710, USA,
Tel: 254-399-9635 or 800-929-2756,
Fax: 254-776-3767, business@aslo.org
http://www.sgmeet.com/aslo

Advertising: Helen Schneider Lemay, ASLO Business Manager, Tel: 254-399-9635 or 800-929-2756; business@aslo.org

The *L&O Bulletin* is published quarterly by the American Society of Limnology and Oceanography, 5400 Bosque Blvd., Suite 680, Waco, TX, 76710, USA. Postage paid at Waco, Texas. POSTMASTER: Send address changes to ASLO Business Office, 5400 Bosque Blvd., Suite 680, Waco, TX, 76710, USA.

Subscription price to regular members is included in annual dues. Information on institutional subscriptions is available upon request from the ASLO Business Office.

Views expressed in this publication do not necessarily reflect official positions of the American Society of Limnology and Oceanography unless expressly stated.

The *L&O Bulletin* publishes brief articles of broad interest to the ASLO membership, Letters to the *Bulletin* (typically responses to articles), and ASLO News on a quarterly basis. Information on the preparation and submission of articles and letters can be found on the ASLO web site (www.aslo.org). It is recommended that you contact the editors before preparing an article or letter.

THE LEGACY OF JAMES G. NEEDHAM: A CENTURY OF LIMNOLOGY AT CORNELL UNIVERSITY AND THE FIRST COURSE ON LIMNOLOGY IN THE AMERICAS

Nelson G. Hairston, Jr., *Department of Ecology and Evolutionary Biology, Cornell University, Ithaca, NY 14853; ngh1@cornell.edu;* ***Gene E. Likens,*** *Cary Institute of Ecosystem Studies, Millbrook, NY 12545; likensg@caryinstitute.org*

THE ROUTE TO CORNELL

James G. Needham taught the first limnology course at Cornell University during spring semester 1908. On April 18, 2009, Cornell limnologists celebrated this event with a day-long symposium of talks and posters presented by former faculty, former undergraduate students, graduate students, and postdocs who have gone on to successful careers of their own in limnology.

By exploring Needham's archived letters, papers, and photographs in the "Rare and Manuscript Collection" of the Cornell University Library, we have reconstructed the details of his arrival at Cornell and the early days of the limnology program. In the process, we became reasonably certain that his course was also the first in limnology taught in the United States and indeed in the Western Hemisphere. It is possible that it was also the first formal limnology course taught anywhere in the world, but we will return to that thought later.

James Needham obtained his Ph.D. degree working with the entomologist, John H. Comstock, at Cornell University in 1898. He arrived from Knox College, Illinois, where as an undergraduate student he was already fascinated by aquatic insects, holding extended correspondence about odonates with some of the best known academics, nationwide, in this field. The summer before arriving at Cornell for graduate study, Needham spent a month visiting Charles Hart at the Illinois State Laboratory of Natural History (later the Illinois Natural History Survey). The "Survey" was directed at that time by its founder Stephen A. Forbes, who a decade earlier had written his seminal paper "The Lake as a Microcosm" (Forbes 1887), and it may have been during this brief visit that Needham first got a taste of a broader perspective on freshwater science. Limnology was a young but growing field at the turn of the last century, with A.-F. Forel in the process of publishing his three-volume monographic work on Lake Geneva (Forel 1892, 1894, 1904), and E. A. Birge at the University of Wisconsin, Madison, engaged in his early and fundamental studies of the Cladocera (Birge 1898) and after 1905 his influential research on the physical and chemical properties of lakes with Chauncy Juday (Birge and Juday 1914). It was in this climate that Needham obtained his degree and took his first faculty position at Lake Forest College, Illinois.

Needham stayed at Lake Forest College for eight years teaching primarily introductory biology, but he clearly chafed at this work and on the back of a letter that Comstock had sent to him in 1905, he penciled a note to himself: "Discuss my getting ready for something new in limnology." In the winter of 1906, he acted and wrote to Comstock: "Is it not time that Cornell University had a professorship in limnology, or freshwater biology? I am suffering for a chance to undertake university work of that sort." He went on to say: "There can be no doubt that limnology is a proper subject for university instruction. A general course would have culture value equal to any other general science course. What wonderful beauty and interest its material offers! Ecology is at its best pedagogically in this subject." Comstock replied to Needham that spring saying that his "limnology proposition was extremely well received" by the Cornell administration and by summer Needham was hired. He began as an Assistant Professor at Cornell in the spring term of 1907, when based on some accounts he may have first taught limnology. More certain is the fact that "Course 19. General Limnology… Assistant Professor Needham" was first listed in the Cornell University course catalog for second term 1907-1908.

NEEDHAM AT CORNELL

Needham brought enormous energy to his position, establishing the "first permanent limnological station for research and investigation" (*Cornell Alumni News* 13 Nov. 1907) on the shores

of Cayuga Lake. In 1916, he and his assistant, J.T. Lloyd published the first English language limnology text *The Life of Inland Waters* (Needham and Lloyd 1916) with a subhead of "An elementary text book of fresh-water biology for American students," described by E.A. Birge (Birge 1916) in a review in *Science* as "… a very good and very useful book … well planned, well executed and well illustrated" though "the emphasis on insects will seem somewhat disproportionately large to students of other groups." The latter is perhaps not surprising given Needham's passion for insects and the fact that his course was offered through the Department of Entomology and Limnology. Nevertheless, the book was broader and contained major chapters on "The Nature of Aquatic Environments," "Types of Aquatic Environment," and "Inland Water Culture." It is unfortunately ingrained in numerous sources that Paul Welch's 1935 text *Limnology* was the first American limnology text. For example, McIntosh (1985) in his history of ecology gave Welch this credit despite the fact that he cited the Needham and Lloyd (1916) book in another context. McIntosh seems not to have understood that he was holding a limnology text in all but title: complete, in addition to its emphasis on the adaptations of organisms to their aquatic habitat, with extended discussion of such limnological phenomena as light penetration, thermal structure and mixing, dissolved gasses, and the reactions of inorganic carbon.

Both during his 26-year career at Cornell and after his retirement in 1935, Needham contributed thoughtful commentary, often in the journal *Science*, on the state of limnology, biology, and the scientific endeavor nationally. In a 1930 review of the teaching of hydrobiology for the U.S. National Research Council, he pointed out that although there were courses at 16 universities in the U.S. and Canada, the situation was far from perfect since in nearly every case the courses were taught by individuals "voluntarily in addition to other teaching or administrative work that is required of them" (Needham 1930a). On biological nomenclature, he wrote objecting to the practice of creating new genera, subfamily, and family names apparently for the primary purpose of having the author's own name enshrined for the future: "A name is a name and not a memorial inscription" (Needham 1930b). He had a healthy skepticism about the value of report writing, noting that Comstock, as chair of the Department of Entomology at Cornell, "… didn't ask for reports at stated intervals; he asked only for reasonable accomplishment." (Needham 1946). Elsewhere he commented that the value of reporting depends upon the reason for the report: "There are reports and reports. For the making out of reports merely to comply with governmental red-tape, I do not care to train [students]… And as to the training needed for making reports of the results of investigation, it is often training in restraint that is most needed." He went on to point out that for writing up research he "set but three requirements before students in [his] own laboratory: (1) clear analysis of the subject matter, (2) simple drawings, (3) good English – and not too much of it." (Howard and Needham 1919).

NEEDHAM'S LEGACY

Until he retired in 1935, Needham taught general limnology with the catalog description: "An introduction to the study of the life of inland waters. Aquatic organisms in their qualitative, quantitative, seasonal, and ecological relations." Following Needham's retirement, the course was taught by at least four different people between 1935 and 1948. David Chandler was hired to teach it in 1949, and when he left for the University of Michigan in 1953, Clifford Berg replaced him. In 1965, the administrative structure of biology was reorganized at Cornell and Jack Vallentyne, who had been teaching Evolutionary Biology in the old Zoology Department, took over teaching "Limnology" with a new faculty member, Donald Hall, as a part of the newly formed Section of Ecology and Systematics within the Division of Biological Sciences. It was during this period that Hall with colleagues William Cooper and Earl Werner carried out their remarkable experimental ecosystem study using Cornell's replicate ponds. Vallentyne and Hall, and then Hall by himself, gave the limnology course a more distinctly ecosystem perspective, while Berg continued to teach a more organismally orientated course with the title "Aquatic Entomology and Limnology."

Gene Likens moved to Cornell in 1969 after both Vallentyne and Hall left for positions at other institutions. Likens strengthened the ecosystem, physical, and biogeochemical perspective of the limnology position, and he and his students carried out many of the well-known whole-ecosystem studies at the Hubbard Brook Experimental Forest and Mirror Lake in the White Mountains of New Hampshire while he was on the faculty at Cornell. At the same time, Likens grew the limnology course to its largest enrollment of over 125 students during the 1970s. It was during this period that Berg retired and was replaced by Barbara Peckarsky, whose research focus on stream insect ecology redirected Berg's former course offering to "stream ecology" and "freshwater invertebrates" within the Department of Entomology (Limnology having been dropped from the department's name in the 1970s). In 1983 Likens left Cornell to found the Institute of Ecosystem Studies in Millbrook, New York, becoming the first director and president. Cornell's limnology course was taught by Charles A.S. Hall while Likens was on leave in 1975 and by David Strayer (Ph.D. with Likens) and Paul Murtaugh in the two years immediately following Likens' departure. Nelson Hairston, Jr. joined the faculty of Ecology and Systematics in 1985 and continued the ecosystem perspective of the limnology course, but also brought his organismal and evolutionary interests to its instruction.

The number of faculty members at Cornell whose research interests were directly focused on limnology greatly increased from a single faculty member from Needham's time through the early 1960s to nine tenure-track faculty by 2005. A large number of other faculty on campus have had research interests in limnology or related to limnology (broadly defined), and additions to this faculty group came through hires not only in the Section of Ecology and Systematics (now Department of Ecology and Evolutionary Biology) and Entomology, but in other departments including, Agronomy (now Earth and Atmospheric Sciences), Civil and Environmental Engineering, Biological and Environmental Engineering, and especially in Natural Resources. The Cornell Biological Field Station on Oneida Lake grew from its establishment in 1955 to the present into a significant site of limnological research and instruction

for faculty, graduate students, and undergraduate interns through the efforts of a succession of visionary directors from J. Forney to E. Mills and now L. Rudstam.

THE FIRST LIMNOLOGY COURSE?

Was Needham's limnology course the first in the world? There would seem to be only three other serious candidates in the United States and the Americas more broadly. The course at the University of Wisconsin was first taught in 1909 by Chauncey Juday (Beckel 1987). E.A. Birge was heavily involved in administration as dean and university president. Stephen Forbes as director of a state laboratory apparently did not teach any formal course, including limnology. Paul Welch, author of the text "Limnology" in 1935 did not begin teaching limnology at the University of Michigan Biological Station until 1922 (Eggleton 1961).

In Europe, F.-A. Forel taught medicine at the University of Lausanne, Switzerland, and there is no record of his having taught a formal course in limnology. Einar Naumann in Sweden was only 17 years old when Needham first taught limnology. In Germany, Otto Zacharias began "Ferienkurse" (vacation courses) on "life in fresh waters" at the Biological Station at Plön in 1899, but this was continuing education for high school teachers (W. Lampert, personal communication), not college students. August Thienemann obtained his Ph.D. degree in 1905, and was put in charge of a hydrobiological station in Munster in 1907 before becoming director of the hydrobiological station in Plön in 1917 (van Oye 1958). It seems unlikely that he taught a limnology course as early at 1908, but this remains uncertain at present. The Freshwater Biological Association laboratory in the English Lake District was not established until 1929. Are there other candidates? The authors would welcome any additions to, or corrections of, the information they have accumulated. For now, however, we claim precedence for James Needham and his prescient insistence that Cornell University hire a limnologist.

This article also appears in the Newsletter of the Societas Internationalis Limnologae.

REFERENCES

Beckel, A.L. 1987. Breaking new waters: A century of limnology at the University of Wisconsin. *Transactions of the Wisconsin Academy of Sciences, Arts and Letters*, Special Issue, 122 pp.

Birge, E.A. 1898. Plankton studies of Lake Mendota. II. The Crustacea of the plankton from July 1894, to December 1896. *Transactions of the Wisconsin Academy of Sciences, Arts and Letters* 11:274-451.

Birge, E.A. and C. Juday. 1914. A limnological study of the Finger Lakes of New York. *Bulletin of the U.S. Bureau of Fisheries*. 32:523-609.

Birge, E.A. 1916. Review of "Life of Inland Waters." *Science* 44:683-684. Forbes, S.A. 1887. The lake as a microcosm. *Bulletin Science Association of Peoria, Illinois*, 1887, 77-87.

Eggleton, F.E. 1961. Paul Smith Welch 1882-1959. *Hydrobiologia* 17:259-261.

Forbes, S.A. 1887. The lake as a microcosm. *Bulletin Science Association of Peoria, Illinois,* 1887, 77-87.

Forel, A.-F. 1892, 1895, 1904. Lac Léman: monographie limnologique. Vol. 1-3. Lausanne, Rouge

Howard, L.O., and J. G. Needham. 1919. Methods of securing better cooperation between government and laboratory zoologists in the solution of problems of general or national importance. *Science* 49:454-458.

McIntosh, R.P. 1985. The background of ecology: Concept and theory. Cambridge Univ. Press. 383 pp.

Needham, J.G. 1930a. The teaching of hydrobiology and agriculture in American universities. *Science* 71:265-266.

Needham, J.G. 1930b. Scientific names. *Science* 71:26-28.

Needham, J.G. 1946. The lengthening shadow of a man and his wife – I. *The Scientific Monthly* 62:140-150.

Needham, J.G. and J.T. Lloyd. 1916. The life of inland waters: An elementary text book of fresh-water biology for American students. Comstock Pub. Co. 438 pp.

van Oye, P. 1958. Prof. Dr. August Thienamann 75 Years. *Hydrobiologia* 11: 182-183.

Welch, P.S. 1935, Limnology. McGraw Hill. 538 pp.

A GUIDE TO FUNDING IN AQUATIC SCIENCES AT THE NATIONAL SCIENCE FOUNDATION

Saran Twombly, *Division of Environmental Biology, National Science Foundation, Suite 635, 4201 Wilson Boulevard, Arlington, VA 22230; stwombly@nsf.gov;* ***David Garrison,*** *Division of Ocean Sciences, National Science Foundation, Room 725N, 4201 Wilson Boulevard, Arlington, VA 22230; dgarriso@nsf.gov;* ***Roberta Marinelli,*** *Office of Polar Programs, National Science Foundation, Room 755S, 4201 Wilson Boulevard, Arlington, VA 22230; rmarinel@nsf.gov*

Research in the aquatic sciences is well supported by the National Science Foundation (NSF) and benefits from being appropriate for programs that span several directorates, offices, and divisions. Ironically, because funding is not consolidated in a single program, and because there is some confusion about where to apply for it, the general impression is often that aquatic research is underfunded by the NSF. This brief article is offered as a rough field guide to the funding opportunities available. Questions should be directed to cognizant program officers (listed below) if this article does not provide the guidance you need. In addition, we offer some tips for successful proposals and a brief view of the ontogeny of a proposal once it is submitted to the Foundation.

TARGETING THE RIGHT PROGRAM

The NSF funds basic research and the appropriate source of funds depends fundamentally on the questions you ask. Successful projects convince reviewers that results will contribute significantly to current understanding of some central, basic process, theory or concept. Research that crosses traditional disciplinary boundaries and environmental domains is often reviewed by two or more programs, one of which leads the review process.

Current support for freshwater and marine research comes primarily from two directorates—Biological Sciences and Geosciences—and from the Office of Polar Programs (OPP). Programs in the Directorate for Biological Sciences (BIO) focus on biological processes at all levels of organization, while the Geosciences Directorate (GEO) considers questions encompassing physical, chemical and biological processes in an explicit earth science system context. Funding for polar research by programs in OPP in part reflects the need for unique logistic support for research at remote, high-latitude locations.

This division of labor is not always crisp. For example, the Biological Oceanography Program (GEO, Division of Ocean Sciences) supports research on ocean ecology, and the Sedimentary Geology and Paleobiology Program (GEO, Division of Earth Sciences) supports studies of the changing aspects of life, ecology, environments, and biogeography in geologic time based on fossil plants, animals, and microbes. There is often considerable overlap between the two directorates - for example in the new Emerging Topics in Biogeochemical Cycles emphasis (a recent Dear Colleague Letter), a new Multi-Scale Modeling initiative and the now retired BioComplexity in the Environment Program.

Geography and habitat are important considerations in directing your proposals. The Office of Polar Programs funds research unique to Antarctica (Antarctic Sciences Program) and the Arctic (Arctic Sciences Program). The Antarctic Organisms and Ecosystems Program considers proposals for marine and freshwater research at the genomic, physiological, population, or ecosystem level; multidisciplinary studies (e.g., including physical or biogeochemical processes in an oceanographic context) are welcomed. Studies that are directed specifically at organismal function, or proposals that include polar and nonpolar components, are often co-reviewed with programs in the BIO Directorate or in Ocean Sciences (GEO Directorate).

Research in the deep oceans and the Great Lakes is generally funded through the Division of Ocean Sciences, while that on inland aquatic habitats (freshwater or saline lakes and ponds, wetlands, streams and rivers) is funded through various programs in the BIO Directorate. Estuarine research is funded by programs in either the BIO Directorate or the Division of Ocean Sciences (GEO). In practice, Biological Oceanography covers habitats seaward from salt marshes or intertidal zones, programs in Biological Sciences fund salt marsh and intertidal research, and many projects in these habitats are considered by two or more programs spanning the two directorates.

One area of frequent confusion concerns basic ecological research at population, community and ecosystem levels. Although funding sources for research in the open ocean and the Great Lakes versus that in small inland ponds may be clear, those for a variety of coastal habitats and for some ecological questions often are not. The Biological Oceanography Program now advises investigators that appropriate proposals are those with a strong ecological context and that address questions within the context of understanding ocean systems. These ecological projects should scale up to, or inform, large-scale geological processes that act over ocean basins (for example, climate change or ocean acidification).

Complementing the ecological research funded in GEO, several programs in the Division of Environmental Biology (DEB, BIO Directorate) support population, community and ecosystem-level investigations of coastal and inland aquatic habitats (lakes, ponds and reservoirs; rivers and streams; wetlands) and their inhabitants. If your research addresses basic ecological questions in any of these habitats, then DEB is the best (initial) home for your proposal. In addition, research in molecular biology and biochemistry, genetics, cell biology, physiology, developmental biology, neurobiology, evolutionary biology or phylogenetic systematics of both freshwater and marine organisms should be directed to programs in the Directorate for Biological Sciences. The Divisions of Molecular and Cellular Biology, Integrative Organismal Systems, and Environmental Biology routinely fund research on aquatic organisms or in aquatic habitats.

The Dynamics of Coupled Natural and Human Systems (CNH; NSF 07-598) has recently been established as a multi-directorate program that includes the BIO Directorate, the GEO Directorate, and the Directorate for Social, Behavioral, and Economic Sciences. It promotes quantitative, interdisciplinary analyses of interactions among human and natural systems at diverse scales, and several recent CNH awards target aquatic sciences. CNH projects must examine the full range of coupled interactions and feedbacks among relevant systems. Successful proposals are usually submitted by research teams that include expertise from the natural sciences (biological sciences, geosciences, and/or physical sciences) and human sciences (social sciences, behavioral sciences, and/or engineering).

To summarize, two points are important in trying to sort out the best program for your research proposals, particularly in areas of obvious overlap. First, NSF programs change periodically, and we update our web pages to communicate these changes. As a result, the program that funded your research five or 10 years ago may not currently be the most appropriate source of funding. It is always a good idea to check current webpage descriptions for individual programs (www.nsf.gov) and to contact program officers in programs that are potentially appropriate for your research. Second, programs in the BIO Directorate frequently co-review proposals with GEO programs, as well as across the Foundation. Frequent co-review and cooperation between programs ensure that research bridging programmatic foci receives fair and comprehensive review. We encourage you to contact program officers by phone or e-mail, to make sure that your project fits within the purview of a particular program. In addition, browsing existing recent award abstracts can help to determine the appropriate program for your proposal.

A FEW CHARACTERISTICS OF SUCCESSFUL PROPOSALS

Programs across the Foundation have experienced three recent trends. First, a larger number of more diverse types of academic institutions are expecting federal funds. Second, the number of requests for NSF funding is increasing. Third, budgets have been flat or increased only slightly over the past five to eight years (depending on directorate). Consequently, pressure to secure research funding is at an all-time high.

One response to these trends is to make sure you understand your funding source. Not all projects or proposals in aquatic sciences are appropriate for NSF, either because the subject of the project or the approach used is inappropriate. The questions posed may be applied rather than basic, or proposed approaches may be descriptive rather than question- or hypothesis-driven. If you aren't sure that your research is appropriate for NSF, please contact a program officer (identified following the guidelines above).

Second, don't submit a proposal until it is the very best that you can prepare. In order to convince reviewers to recommend your project for funding, your ideas must be expressed clearly. Clear writing requires clear thinking, and this takes both time and effort. Rough drafts or hastily prepared proposals are rarely successful. In general, it is not a good strategy to submit multiple proposals to a single panel or target date. You are not entering a lottery when you submit NSF proposals: you compete against yourself, as we are unlikely to fund several projects from a single investigator; several different projects are usually less well developed than a single proposal; and we usually find out quickly if you have submitted the same basic project, with only slight modifications, to different programs. In this case and despite extreme uncertainty, bet-hedging is risky.

Fundable proposals share several, basic characteristics:

a) Present new, original, exciting ideas that hook your reviewers

b) Have a strong, clear conceptual or theoretical basis. The goals of research should be linked to questions of fundamental or broad significance.

c) Provide a clear description of how research advances current understanding of an important biological, geological, ecological, etc., question

d) Outline a clear set of hypotheses, questions, and predictions that directly relate to the conceptual framework. Proposed research and data collected should directly address motivating questions or hypotheses. Can results distinguish among competing hypotheses or alternatives?

e) Justify the study system, species, and response variables. Why are response variables the best to answer the research questions (rather than just the most convenient to measure)?

f) Present a focused and realistic work plan and a realistic budget

g) Demonstrate knowledge of subject area and experience with appropriate methods

h) Broader impacts present reasonable plans in some detail. Don't just repeat past activities, but describe broader impacts of this particular study. And don't present a laundry list. Reviewers are usually far more impressed by specific impacts and plans to implement them, than by a longer list with no clear plans.

Are preliminary data necessary? This is a difficult question to answer succinctly. In some circumstances, preliminary data are necessary; they convince your reviewers that the phenomenon you want to study actually occurs, for example, or that the new methods you wish to employ actually work. In other cases, preliminary data may be helpful but they are not essential. This is particularly true if you have previous experience (and some publications) with the organism, process, or pattern you wish to study.

All of these tips add up to a document that will be convincing to your peers. If you want to increase your chances of success, and if you have not submitted many successful NSF proposals, it is a good idea to ask some peers (but not your friends) to read and comment on your proposal before you submit it. Successful NSF proposals convince peer reviewers that the research is intellectually exciting and timely. If your colleagues find flaws in your proposal, NSF reviewers likely will as well. Finally, it is important to diversify your funding sources. This is often difficult for people who engage in strictly basic research, but it is a goal that will help to ameliorate the effects of competition for NSF funding.

PROPOSAL ONTOGENY

Have you ever wondered what happens to your proposal once you push the 'submit' button in FastLane, or why it takes six months to hear any news of its fate? Figure 1 diagrams the life cycle of a proposal once it is submitted to an appropriate program. Proposals are submitted to a specific deadline or a target date, following the Grant Proposal Guide for unsolicited proposals submitted to core programs or specific solicitations (for example, the Dynamics of Coupled Natural Human Systems, NSF 07-598). All submitted proposals are first checked for compliance with the Grant Proposal Guide and the particular program solicitation (if appropriate). Make sure your proposal

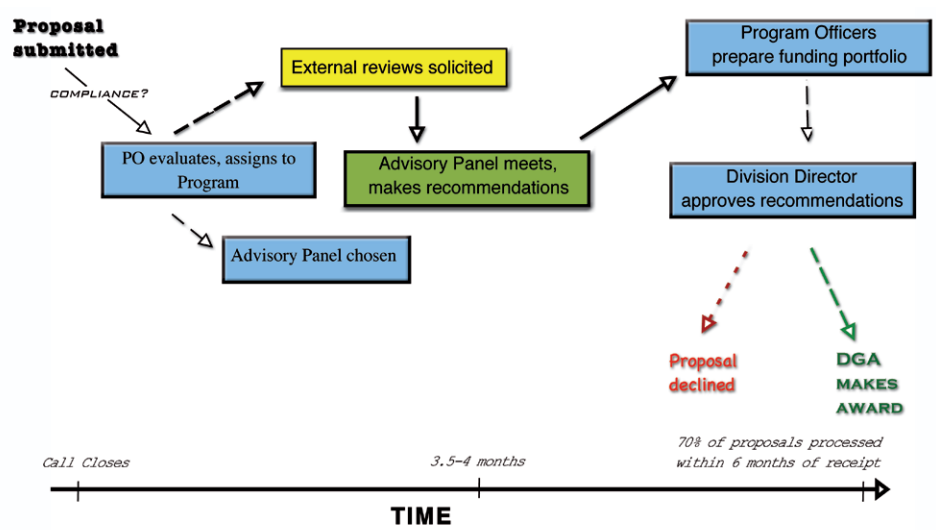


Figure 1. Timeline for NSF actions on most submitted proposals

POINTS OF INITIAL CONTACT

Directorate for Biological Sciences	http://www.nsf.gov/dir/index.jsp?org=BIO	supports research to advance understanding of the principles and mechanisms governing life. Research encompasses the structure and dynamics of biological molecules, cells, tissues, organs, organisms, populations, communities, and ecosystems up to and including the global biosphere.
Division of Environmental Biology	http://www.nsf.gov/dir/index.jsp?div=DEB	supports fundamental research on populations, species, communities, and ecosystems, and evolutionary and ecological patterns and processes at all spatial and temporal scales. Areas of research include biodiversity, phylogenetic systematics, molecular evolution, life history evolution, natural selection, ecology, biogeography, ecosystem services, conservation biology, global change, and biogeo-chemical cycles.
Division of Integrative Organismal Systems	http://www.nsf.gov/dir/index.jsp?div=IOS	supports research aimed at an integrative understanding of organisms, to predict why organisms are structured the way they are, and function as they do.
Division of Molecular and Cellular Biosciences	http://www.nsf.gov/dir/index.jsp?div=MCB	supports fundamental research addressing the dynamic underpinnings of complex living systems at the molecular, subcellular and cellular levels. Questions relating to the origin, organization and properties of macromolecular structures, subcellular and cellular components and the nature of basic life processes.
Directorate for Geosciences	http://www.nsf.gov/dir/index.jsp?org=GEO	supports research in the atmospheric, earth, and ocean sciences to advance scientific knowledge of Earth's environment, including resources such as water, energy, minerals, and biological diversity.
Division of Ocean Sciences	http://www.nsf.gov/dir/index.jsp?div=OCE	supports basic research and education to further understanding of all aspects of the global oceans and their interactions with the earth and the atmosphere. Includes global change research programs and other focus programs.
Division of Earth Sciences	http://www.nsf.gov/dir/index.jsp?div=EAR	structure, composition, and evolution of the Earth, the life it supports, and the processes that govern the formation and behavior of the Earth's materials.
Division of Atmopsheric Sciences	http://www.nsf.gov/dir/index.jsp?div=ATM	Studies of the physics, chemistry, and dynamics of Earth's upper and lower atmosphere and its space environment; Research on climate processes and variations; studies to understand the natural global cycles of gases and particles in Earth's atmosphere.
Office of Polar Programs	http://www.nsf.gov/dir/index.jsp?org=OPP	basic research and its operational support in the Arctic and the Antarctic.

PERMANENT PROGRAM OFFICERS

Division of Environmental Biology	Henry Gholz (Ecosystems, hgholz@nsf.gov); Alan Tessier (Ecology, atessier@nsf.gov); Saran Twombly (Evolutionary Processes, stwombly@nsf.gov)
Division of Integrative Organismal Systems	Steve Klein (Developmental Biology, Sklein@nsf.gov); Diane Witt (Neurobiology, dwitt@nsf.gov); Michael Mishkind (Physiological and Structural Systems, mmishkin@nsf.gov)
Division of Molecular and Cellular Biosciences	Kamal Shukla (Molecular, kshukla@nsf.gov); S. Porter Ridley (Genetics, sridley@nsf.gov)
Division of Ocean Sciences	David Garrison (Biological Oceanography, dgarriso@nsf.gov); Don Rice (Chemical Oceanography, drice@nsf.gov); Eric Etsweire (Physical Oceanography, etsweire@nsf.gov)
Division of Earth Sciences	H. Richard Lane (Paleontology, hlane@nsf.gov); L. Douglas James (Hydrology, ldjames@nsf.gov); Enriqueta Barrera (Geobiology, ebarrera@nsf.gov)
Division of Atmospheric Sciences	Jay Fein (Climate and Large-scale Dynamics, jfein@nsf.gov); David Verardo (Paleoclimates, dverardo@nsf.gov)
Antarctic Sciences	Roberta Marinelli (Organisms, Ecoystems, rmarinel@nsf.gov); Peter Milne (Oceans and Atmosphere, dmilne@nsf.gov)
Arctic Sciences	Bill Wiseman (wwiseman@nsf.gov)
Dynamics of Coupled Natural Human Systems	Thomas Baerwald (tbaerwal@nsf.gov)

complies with the required guidelines – in some cases we can allow noncompliant proposals to be fixed, but some must be returned without review.

Once proposals are compliant, program officers read them to determine whether they are appropriate for the program to which they were submitted or are likely candidates for co-review with another program. Appropriate proposals are assigned to a managing program officer, who then chooses a set of *ad hoc* reviewers for each proposal. Simultaneously, a review panel is assembled that includes panelists with the range of expertise required to evaluate the submitted proposals. Individual panelists review some subset of these. Meetings of review panels occur at NSF approximately three to four months after proposals were received. At these meetings, panelists discuss all proposals and their associated reviews, and make recommendations on the quality of each proposal with respect to intellectual merit and broader impacts of the research proposed.

Panel recommendations are considered carefully by program officers, particularly with respect to our budgets and funds available. In developing a portfolio of proposals to recommend for funding, we also consider broadening participation (gender, ethnicity and experience of the investigators), geographical distribution, type of institution (research vs. undergraduate), the riskiness of the proposed research, and other factors. Our resulting portfolio must be approved by our Division Director before we can recommend a project for an award (and contact the investigators), or recommend that a proposal be declined. These same recommendations require the Division Director's signature before official action is taken. Investigators then receive an official letter of decline or, some four to six weeks later, an award letter prepared by the Division of Grants and Agreements.

These days, you are in good company if your proposal is declined. Depending on the tenor of your reviews, revision and resubmission can be viable next steps. First, read your reviews very carefully. Talk with the managing program officer. Do not resubmit immediately (for the very next target date) unless the concerns raised are very minor. You need to decide whether reviewers' concerns or the panel summary make sense, in light of your overall research goals. If you do not take time to think through reviewers' suggestions, you may well be subject to contradictory conclusions from successive panels, with the overall result that a previously promising study becomes weaker, more diffuse and perhaps unsupportable. Keep in mind that there is no strategic reason to submit a proposal to every target date or deadline (you do not necessarily increase your chances of being funded by doing this) and that the NSF does not guarantee that an official decision will be made, and reviews released, in order for you to submit to the very next target date.

WHO REVIEWS YOUR PROPOSAL, AND WHY?

NSF is proud of its peer review system, and members of the scientific community work hard to ensure that each proposal receives a fair and expert evaluation. Most proposals receive a mixture of *ad hoc* reviews and reviews from panelists. These two types of reviews differ. *Ad hoc* reviews are solicited from researchers who are experts in the particular area (conceptual, methodological) covered by a project. They evaluate a very small number of projects (with luck, no more than two per funding cycle) for their intellectual merit and their broader impacts. Panelists review a proposal using both criteria, but can compare among proposals because they hear about all of them. The panelists reviewing your proposal may not be experts in your field. As a result, it is very important that you do not assume your reviewers are all experts in your field and are intimately familiar with your work and its importance. You must convince a general, intelligent, scientific audience that your research deserves support.

NSF asks reviewers to address two basic criteria. The first of these is a proposal's intellectual merit. Will your research advance knowledge and understanding in the field? Is it creative and original? Is the research design clear and comprehensive? The second major criterion is the project's broader impacts. NSF is very serious about the broader impacts of a study (proposals that do not address broader impacts will be returned without review), but this criterion rarely supersedes intellectual merit. There are several types of broader impacts, but no expectation that a single proposal should cover all of them. Choose the one(s) that best fits your research and for which you can make the most convincing case. As mentioned above, provide a plan (for example, how will you find/recruit minority undergraduate, or how will your results inform management and conservation). Don't rest on past accomplishments; we evaluate the broader impacts of the current proposal. And keep in mind that in the near future, NSF will require public access to your data within some reasonable period of time after it is collected.

Program officers are always available, either by e-mail or telephone contact, to answer questions that this short guide may not address or address adequately.

A KERNEL OF TRUTH: MICROWAVE POPCORN MAKES IT EASIER TO TEACH BASIC STATISTICS

Romi L. Burks, *Associate Professor of Biology, Southwestern University, 1001 East University Avenue, Georgetown, TX 78626, Phone: 512-863-1280, burksr@southwestern.edu*

For more information about this exercise, complete details (instruction manual, handouts and student assessment guidelines) for "Popcorn Statistics" visit: http://people.southwestern.edu/~burksr/test/innovative/index.html

Just like nutrients, recycling ideas about teaching occurs across large spatial scales from large Research I universities to small 4-year colleges. The use of popcorn in this example of biostatistics originated from a legendary course, "Statistics for Experimenters," taught by statisticians Bill Hunter and George Box at the University of Wisconsin (UW) in the 1970s

(Carpenter, personal communication). Their course eventually gave rise to the original textbook of the same name (Box et al. 1978). Given the prominence of several limnologists trained at UW, one can only speculate about the extent that this course has impacted the aquatic science community. To test their skills for application and interpretation, UW students performed their own experiment using common household goods. Past students found popping Jiffy Pop® on the stove for different durations or using different burners produced statistically differentiable and repeatable results. One of these students (S. Carpenter) eventually rose to the position of professor himself and repackaged the exercise to teach statistics to whole new generations of limnologists. Consequently, use of popcorn for teaching statistics has now popped up at several places with distant connections to the original UW course.

As the first food intentionally popped, popcorn occupies an important place among snack foods equaling a 1.28 billion dollar industry with Americans consuming 17 billion quarts annually (Malovany 2007). Having students literally consume the topic of statistics through an active learning approach, such as popping popcorn, may help overcome math anxiety (Conners et al. 2003) and create a more relaxed learning environment and better retention (McKeachie and Svinicki 2005). An intellectual skeptic might remark that "there are no new ideas, just old ones repackaged in new ways." Along those lines, microwave popcorn serves as a great model for a statistical exercise because of its versatility in flavors and sensitivity to environmental factors. In addition, this exercise takes students all the way through the scientific methods, from hypothesis formation to data collection to analysis and interpretation. Rossman and Chance (1997) put together a top ten list for teaching statistical reasoning (Table 1) and this exercise uses popcorn to address each of the ten principles.

Table 1. Match between popcorn statistics and a "Top Ten" list of recommendations for teaching statistical inference.

	Rossman and Chance (1999)	Components of "Popcorn Statistics"
10	Have students perform physical simulations to discover basic ideas of inference.	Students physically pop the popcorn, measure pieces and count popped versus unpopped.
9	Encourage students to use technology to explore properties of inference procedures.	Students can build the components of variability into a spreadsheet and then later a statistical analysis program.
8	Present tests of significance as *p*-values versus rejection ranges.	Students answer questions within the exercise with supporting *p*-values.
7	Accompany tests of significance with confidence intervals whenever possible.	When measuring popcorn sizes, students observe how replication yields a more accurate representation of the mean.
6	Help recognize that insignificant results give useful information.	Students learn differences between statistically significant and scientifically meaningful.
5	Stress limited role that inference plays in statistical analysis.	Students create several populations, sample randomly and discuss the difference between true replication and pseudoreplication.
4	Always consider the issues of data collection.	Students brainstorm about how they will standardize methods or what decisions in data collection might include unintentional bias.
3	Always examine visual displays of the data.	Students can graph both relational and categorical data.
2	Help students to see the common elements of inference procedures.	Students gain a sense of what it means to reject or fail to reject null hypotheses through repeated analyses and annotation of their analysis.
1	Insist on complete data presentation and interpretation in the context of the data.	Students complete four exercises that include data presentation and analysis. In addition, the data sets can be used repeatedly.

POPCORN STATISTICS *A PRIORI* CONSIDERATIONS

Microwave popcorn comes in enough varieties that this exercise can be tailored to meet class preferences, interests or product availability. This expanded exercise contains four parts (Tables 2, 3):

1) Conducting t-tests between two types (e.g. buttered versus 94% Smart Pop) of the same brand of popcorn (e.g. Orville Redenbacher®, OR) popped for the same amount of time (one minute and 30 seconds = 90 seconds) in the same microwave;
2) A one-way analysis of variance (ANOVA) using at least three brands (e.g. OR, Act II and Pop Secret), of the same type (e.g. Butter), popped for the same amount of time (90 seconds) in the same microwave;
3) 2^3 factorial ANOVA (i.e. three factors, each with two levels) with two brands of popcorn (e.g. OR and Act II) of the same type (e.g. Butter) exposed to two different microwaves and two different popping times (75 or 90 seconds); and
4) Regression and correlation analyses with data from Part 3 (or all bags if desired).

Besides hypothesis testing, students can also conduct descriptive statistics to examine distributions. Instructors or student groups could also alter brand and type choices of popcorn to compare and contrast brand names versus generics, sweet versus salty versions or the yield compared to price of organic products. However, before beginning the exercise, the instructor should consider certain issues.

Student experience and time investment. It takes one lab period (two to three hours) to distribute the 50 bags for popping (Table 3), introduce a framework for conducting statistical analysis and discuss methodology. Depending on their experience and aptitude, students required one to three additional sessions to learn how to conduct analyses with statistical software. Sophomore students used more time for data synthesis, analysis and interpretation (3 hrs./week for 4-6 weeks) than upper-level students (3 hrs./week for 3 weeks). Therefore, the entire exercise easily involves considerable time investment.

Replication and Correction Factors. Individual-sized servings of popcorn greatly cut down on the time it takes to count outcomes versus larger bags. A treatment replicate (N) represents the type of popcorn and the conditions under which popping occurs (e.g. OR® Butter, Microwave A, 90 seconds). The exercise involves a total of 11 treatments as one treatment from the first and third part of the exercise (e.g.

OR® Butter and Act II Butter, respectively, Microwave A, 90 seconds) can be used again in the 2^3 factorial design.

The majority of this exercise employs five replicates, for popcorn pieces or bags for calculating yield (although see exception in Part 1). From pilot data, five represented the minimum sample number that provided reasonable estimations of means (± 1.5 SD). In addition, a minimum of five replicates (i.e. five individual bags) provided enough degrees of freedom for statistical analyses of whole bag measures.

Contents of individually-sized bags of popcorn vary both within and across brands. For example, Orville Redenbacher® makes two types of individually-sized bags of popcorn, Butter Flavor (1.5 oz) and the Smart Pop (1.2 oz). Kernel size (popped) does not likely depend on bag size, and yield represents a percentage that can be compared across bags. However, quantitative components of yield (i.e. number of popped kernels) depend on bag size. Because initial package weight differs, students should calculate and apply correction factors by using basic ratios to convert smaller sizes to the largest size (Table 3).

PROCEDURES

After popping a bag of popcorn under conditions belonging to a specific treatment (i.e. brand, type, duration and microwave), students then measure five things: 1) Number of burned pieces of popcorn (B); 2) Total number of popped kernels (P); 3) Number of unpopped kernels (U); 4) Total weight of bag contents; and 5) Maximum length of five pieces of popcorn (using digital calipers for better precision). Students should work together to come to consensus on criteria for a whole or burned piece of popcorn and consistent approaches for counting and measurement. Although not edible, a burned piece of popcorn still counts as popped. From these data, they can determine edible yield [= (P-B) / (P+U) ⋆100] and average kernel size.

Framework for statistical interpretation. While introductory courses provide the basic mechanics behind statistics, students may not connect the material directly with their discipline. Popcorn statistics asks students to identify specific components of experimental designs and link the concept of treatments with the null hypotheses tested by parametric statistics. During the exercise, instructors should repeatedly ask students this series of 10 questions to build their framework for statistical interpretation (Table 2):

1) What is your scientific question? (Context)
2) What did you measure?
3) How many groups did you use?
4) How many things varied in this experiment (i.e. how many factors and levels)?

Table 2. Summary of statistical analyses, popcorn required, experimental designs, example scientific questions, scientific hypotheses or predictions, statistical hypotheses for main factors, post-hoc tests and interactions for each of four sections. NS = not significant. Levels for time include 75 and 90 seconds. Criteria for rejection of null hypothesis = $p \leq 0.05$.

Framework to Teach Students	Independent t-test	One-way ANOVA	2^3 factorial ANOVA	Regression
Popcorn Required	OR®SmartPop, OR®Butter	OR®Butter, PopSecret and ActIIButter	OR®Butter, ActIIButter	OR®Butter, ActIIButter
Factors	1 (Type = T)	1 (Brand = B)	3 (B, T, Microwave)	NA
Levels	2	3	2	NA
Treatments	2	3	8	NA
Replicates	5	5	5	40
Scientific Question(s) (X and Y= dependent variables; underline = independent factor)	Does the type of popcorn influence X?	Does the brand of popcorn influence X?	Does X depend on brand, time popped, microwave or a combination of factors?	Does a predictive relationship exist between X and Y?
Scientific Hypotheses (Predictions)	Because it contains less butter, OR®SmartPop will exhibit a higher X.	Because it costs more to produce, OR®Butter will exhibit a higher X.	Because it is written on the package, X will depend significantly on the microwave used and time.	Average size (X) exhibits a positive and predictive relationship to bag weight (Y) because larger pieces weigh more.
A Priori Statistics	one-sample KS Test	one-sample KS Test	one-sample KS Test	one-sample KS Test
Statistical Null Hypotheses for Main Factors	$\overline{X}_{OR®SP} = \overline{X}_{OR®B}$	$\overline{X}_{OR®B} = \overline{X}_{PS} = \overline{X}_{ACTII}$	$\overline{X}_{OR®B} = \overline{X}_{ACTII}$ $\overline{X}_{75s} = \overline{X}_{90s}$ $\overline{X}_{MicroA} = \overline{X}_{MicroB}$	m (slope) = 0
Statistical Null Hypotheses for Post-hoc Statistics or Interactions		$\overline{X}_{OR®B} = \overline{X}_{PS}$ $\overline{X}_{OR®B} = \overline{X}_{ACTII}$ $\overline{X}_{PS} = \overline{X}_{ACTII}$	$\overline{X}_{BRAND} \star \overline{X}_{TIME} = NS$ $\overline{X}_{BRAND} \star \overline{X}_{MICRO} = NS$ $\overline{X}_{TIME} \star \overline{X}_{MICRO} = NS$ $\overline{X}_{BRAND} \star \overline{X}_{MICRO} \star \overline{X}_{TIME} = NS$	
Post Hoc Statistics		Tukey's		R2

5) How many treatments versus replicates occurred (Methods)?
6) Based on this experimental design, what statistics should you perform?
7) What are your null hypotheses for each of the statistics performed?
8) What does your resulting p-value tell you about rejecting or failing to reject the null hypothesis for each statistic performed (Results)?
9) How do you now use the word significant in answering your original question?
10) What mechanisms at play (i.e. biological, chemical, or physical) might have contributed to your results (Discussion material)?

Investigation of how cumulative means change with sample size. Students can also perform 'sub-sampling' by measuring pieces of popcorn from each bag. For purposes of data analysis, using the average size of five pieces measured avoids artificially inflating degrees of freedom. Consequently, use of individual bags of popcorn as treatment replicates provides instructional chances to talk about replication versus pseudo-replication (Hurlbert 1984). To further illustrate the idea of how narrower confidence intervals (CI) occur with increasing sample size, students should measure 15 pieces of popcorn from a single bag of the two OR® types used in Part 1 of the exercise.

To avoid bias, students set aside every fifth piece counted for measurement. When graphed, students can identify at which point adding one more sample does not alter the interval substantially. Consequently, from this investigation, students may find that measuring more than 5 pieces might have provided them with less variable data in the overall exercise. They can then discuss the merits of measuring more pieces considering the additional time required.

Additional key points for emphasis. To meet the assumptions required for parametric statistics, students first need to test each dependent variable for normality using non-parametric one-sample Kolmogorov-Smirnov (KS) tests. In contrast to comparison between means, students learn that they do not want to reject the null hypothesis that the data meet a normal distribution. They must identify appropriate p-values ≥ 0.05, learn how to transform data or consider non-parametric statistics.

During Part 1, students should explore the relationship between the calculated t from their t-test and the probability value based on a critical t statistic for a given number of degrees of freedom. The use of a critical t value table offers another opportunity to emphasize the importance of replication in experimental designs. Furthermore, requiring students to first calculate at t-test by hand gives them a better context for the origin of the p-values they see immediately when using a statistical program.

Use of three different brands in Part 2 gives the instructor the opportunity to reinforce the idea that the results of a one-way ANOVA only inform whether or not a significant difference existed among the three (or more) groups, but not where the actual significant differences occurred between groups. For that, students need post-hoc tests. Zar (2007) identified Tukey's multiple comparison tests as a more conservative choice.

Part 3 of this exercise allows students the change to test the scientific validity of the disclaimer that typically occurs on the back of any package of microwave popcorn. Popcorn makers caution that "popping times will vary depending on microwave." The jump from a one factor to a three factor ANOVA eliminates some redundancy and gives more opportunity to examine potential significant interactions (Table 2). As each factor (i.e. brand, time and microwave) has only two levels, this experimental design makes interpretation easier because each independent factor does not require post-hoc tests. The output then yields 7 p-values for students to interpret (three for the main factors, three for the two-way interactions, and a three-way interaction). This example provides repetitious training in annotating results.

The fourth part of popcorn statistics opens the door for students to ask their own questions about the relationships between variables. One goal includes teaching students how correlation and regression differ. A second goal emphasizes the importance of graphing. Rossman and Chance (1999) argue that students should always look at visual outputs of their data, and modern statistical programs offer countless graphing options. Students can also build descriptive

Table 3. Summary of popcorn required for exercise and how each brand and type contributes to the statistical tests. The factor applied to kernel count refers to the correction factors described in the methods.

Microwave Popcorn Brand	Type	No. boxes to buy/ bags per box	No. bags used/ bought	Bag Weight (oz)	Factor applied kernel count	Part of exercise in which data contribute: statistical test
OR® Smart Pop	94% Fat Free Butter	1 box/ 10 bags	5/10 bags	1.2	1.5	1: t-test 2: one-way ANOVA
OR® Butter	Butter	2 boxes/ 10 bags	20/20 bags	1.5	1.2	1: t-test 3 and 4: 2^3 Factorial ANOVA
Pop Secret	Butter	1 box/ 10 bags	5/10 bags	1.5	1.2	2: one-way ANOVA
Act II	Butter	3 boxes/ 8 bags	20/24 bags	1.8	1	2: one-way ANOVA 3 and 4: 2^3 Factorial
Total		7 boxes	50/64			

statistics using Excel™. The broad availability of the program furthers its appeal as a teaching tool. To allay any anxiety about learning spreadsheets, students should have access to a "master" spreadsheet to check their formulas after they have built their own spreadsheet. In contrast, sole use of a statistical program, such as SPSS, only allows students to acquire cursory knowledge of formulas behind statistics. Consequently, they depend too much on the ease of point and click. The act of deriving the formulas first in Excel™ and then verifying results in SPSS promotes deeper understanding.

EXPANSION OF POPCORN STATISTICS AND CONCLUSIONS

The ease and versatility of this exercise allows for multiple possibilities for revision or personalization. For example, one could test if a "popcorn" button on certain microwaves yielded a better outcome than the time advised on the package. Popping individual bags allows each student to contribute a "piece" to the complete data set puzzle (Perkins and Saris 2001) and the requirement of lab exercises from each individual encourages students to be more active in group work. Using data from different experimental designs used in this exercise also helps teach students how to make high-quality appropriate figures.

Besides providing a context for future independent or group experiments, the collective process of popcorn statistics can also serve as a launching point for any number of discussions including scientific ethics, inter-measurer variability (achieved by examining coefficient of variation between different metrics), extrapolations (examined by comparing individual versus full size bags) or even truth in advertising. Mark Twain once famously paraphrased Benjamin Disraeli's opinion "there are lies, damn lies and then statistics." Too often, statistics can be easily manipulated to tell different versions of the same story and students need to consider presentation when they evaluate other work and analyze their own data.

For this aquatic scientist, the kernel of truth in this exercise revealed that microwave popcorn made it easier to teach basic statistics. Interestingly, we found that yield usually did differ significantly by microwave, just as the packages suggested. From the instructor's own perspective, students seemed to enjoy the process of data collection and appeared to retain the basic ideas of experimental design throughout the course. Hopefully, more targeted quantitative assessment will accompany further iterations of popcorn statistics. Exercises like popcorn statistics encourage students to learn to ask questions, define problems, formulate hypotheses and definitions, design experiments, collect data, explore variation, summarize data and communicate their findings. This dedication to active learning styles (McKeachie and Svinicki 2005) increases the probability of creating competent student statisticians.

ACKNOWLEDGMENTS

Dr. Gary Lamberti from the University of Notre Dame and Dr. Steve Carpenter from the University of Wisconsin-Madison provided encouragement and created earlier versions of popcorn statistics that inspired this manuscript. The author thanks Dr. Ed Kain, Megan Fencil, Matt Barnes and Dr. Ben Pierce for comments on the manuscript.

REFERENCES

Box, G., Hunter, S., and W. G. Hunter. 1978. Statistics for Experimenters, 1st ed. Wiley.

Conners, F. A., S. M. McCown, and B. Roskos-Ewoldsen. 2003. Unique challenges in teaching undergraduate statistics. Teach. Psychol. 25(1): 40-42.

Hurlbert, S. H. 1984. Pseudoreplication and the design of ecological field experiments. Ecol. Monogr. 54(2): 187-211.

Malovany, D. 2007. Reality bites. *Snack Food and Wholesale Bakery Magazine.* http://www.snackandbakery.com/content.php?s=SF/2007/06&p=21 Accessed 03 Jan 2007.

McKeachie, W., and M. Svinicki. 2005. McKeachie's Teaching Tips: Strategies, Research, and Theory for College and University Teachers. Houghton.

Perkins, D.V., and R. N. Saris. 2001. A "jigsaw classroom" technique for undergraduate statistics courses. Teach. Psychol. 28(2), 111-113.

Rossman, A. J., and B. L. Chance. 1999. Teaching the reasoning of statistical inference: a "top ten" list. Coll. Math. J. 30(4): 297-305.

Zar, J. H. 2007. Biostatistical Analysis, 5th ed. Prentice Hall.

EU SCIENCE GAINING BY MANY COUNTS, STAGNANT IN OTHERS

***Adrienne Sponberg**, ASLO Director of Public Affairs, P.O. Box 8785, Silver Spring, MD 20907; asponberg@aslo.org*

In 2000, the European Council committed to the Lisbon Agenda with the goal of becoming "the most dynamic and competitive knowledge-based economy in the world." A new report from the European Commission provides a wealth of information on how much progress has been made towards that goal between 2000 and 2006. Upon release of the 2008 Science, Technology and Competitiveness (ST&C) key figures report, EU Commissioner for Science and Research Janez Potočnik noted the importance of research and development in light of the current economic crisis. "In a time of crisis, it is not the moment to take a break in research investments and in innovation. They are vital if Europe wants to emerge stronger from the economic crisis and if it wants to address the challenges of climate change and globalization." Potočnik believes the Commission's initiatives have put the EU "on the right tracks," but warns there is still work to be done.

The report provides 150+ pages of metrics on R&D investment, mobility, and competitiveness. In terms of investment in research and development (R&D), the news is mixed. European investment in R&D grew in real terms by 14.8% (as compared to 10.1% in the US in the same time period). The range in growth between EU countries, however, is substantial. Spain, for

example, increased its investment by 62%; Denmark also bested the European average with a 20% increase. Other countries fell below the average; among them are the UK (12%), Germany (9%), France (8%), and Sweden (4%). And while funding in real terms has increased, the percent of European GDP applied to R&D has stagnated at 1.84%, falling far short of the Lisbon goal of 3.0% GDP. The report cites an underinvestment from the private sector as the reason for the R&D "intensity gap" between the EU and other countries such as the US and China.

Metrics provided in the report show that research in Europe is "opening up" - both through improved mobility among European countries and to the world at large. Potočnik acknowledges the role of mobility in Europe's plans to boost its competitiveness in the report's preface: "An opening up of our research systems and a free circulation of researchers and technologies, the so-called 'fifth freedom' is necessary to increase competition and promote excellence in research." The metrics provided in the report shows that the EU is well on its way to achieving a more open research system. For example, by 2006, half of the national research programs in Europe allowed for participation by non-residents; 20% of these programs allow non-residents to be funded. The report acknowledges that some countries (including the UK, Austria, Belgium, Denmark and the Netherlands) have gone further than others in "opening up their research systems to attract foreign researchers." The UK attracts the most European researchers.

Universities are increasingly linking up across the EU as well, particularly in Western and Northern Europe. One factor that may be driving the increased linkages is increased funding for coordinated research. While the proportion of European to national funding held steady between 12 and 15%, funding for coordinated research increased steadily in real terms between 2000 and 2006. It will accelerate even further in the 7th Framework Program (FP7) between 2007 and 2013, as the funding for coordinated research will more than double.

While Europe accounts for less than 25% of global science and technology, the pool of European researchers is growing. In fact, the number of researchers grew twice as fast in the EU as it did in the US and Japan. In 2005, 100,000 doctoral degrees were awarded in EU-27 compared to 53,000 in the US and 15,000 in Japan. As a group, EU researchers are the world's largest producer of scientific publications. In 2006, 37.6 % of the world peer-reviewed scientific articles had at least one EU author, compared to 31.5 % in the US. However, Europe contributes less than the US to high impact (defined as the 10% most cited) publications.

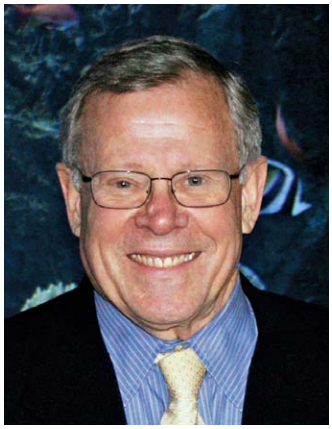
Potočnik hopes the report will be an effective monitoring tool to assess "how well these challenges are being addressed and what progress Europe makes in transforming itself into a knowledge-driven society." The full report (9MB) may be downloaded at: http://ec.europa.eu/research/era/pdf/key-figures-report2008-2009_en.pdf

This article originally appeared in the ASLO Aquatic Science Policy Report. Not a subscriber? Visit http://www.aslo.org/forms/panform.html to sign up!

FEATURES

BEYOND THE IVORY TOWER: AQUARIUM OF THE PACIFIC'S JERRY SCHUBEL

***Adrienne Sponberg**, ASLO Director of Public Affairs, P.O. Box 8785, Silver Spring, MD 20907; asponberg@aslo.org*



With hundreds of millions of visitors around the globe each year, zoos and aquariums are a major venue for educating the public about aquatic ecosystems. In this month's "Beyond the Ivory Tower," President and CEO of the Aquarium of the Pacific Jerry Schubel shares some insight about these "free choice learning centers" and offers advice to scientists hoping to share their research findings with the public.

Jerry Schubel is no stranger to the world of aquatic research. After earning his Ph.D. at John's Hopkins University, he continued to work there as research staff. He then served as associate director of the Chesapeake Bay Institute. In 1974, he helped establish the Marine Sciences Research Center at Stony Brook. For 20 years, he served as dean and director of the Center. During that time, he also served terms as provost and vice president for research and graduate studies at Stony Brook.

In 1994, Schubel's career took an unexpected direction. He got a call from a headhunter regarding the position of president and CEO of the New England Aquarium in Boston. While he had conducted plenty of public outreach as a researcher, up until this time Schubel had spent all of his professional life in academia. That didn't stop him from taking the job, though. A key motivating factor for taking the position was a desire to effect better policies for marine resource management and conservation. Schubel explains, "In order to effect change on the scales we need, we need to have the public more informed and committed to the kinds of changes that are necessary. When FDR was President he made the statement, 'I can only move as quickly as the people will let me.'" Schubel thought the position would be a great opportunity to "move the public along to get them better informed about some of these big issues so they will be more receptive to the kind of policies that academic scientists want to see made." He believes many elected officials would like to see the same policies instituted, but are often hesitant due to lack of public support. "If you're an elected official, or an appointed official, you have to be careful that you don't get too far out ahead of the public or you'll find yourself out of office pretty quickly."

With more than 175 million visitors to zoos and aquariums in North America alone each year, they certainly represent a golden opportunity for scientists to get information to the public. Known as "free choice learning centers" in the business, zoos and aquariums are often thought of in terms of educating

the next generation via field trips and family vacations. Schubel cautions scientists not to discount the value of these institutions in reaching older (voting-aged) guests, though: approximately one-third of visitors to these institutions are adults without children. A study by the Association of Zoos and Aquariums found that "visits to accredited zoos and aquariums prompt individuals to reconsider their role in environmental problems and conservation action, and to see themselves as part of the solution," confirming their role as a means of changing public opinion on matters of conservation (Falk et al 2007).

In 2002, Schubel switched coasts, becoming president and CEO of the Aquarium of the Pacific. The location was appealing to Schubel, but not for the usual presumed rationale of nice weather. More than 20 million people live within an hour's drive of the Aquarium, which is the only large aquarium in southern California. Adding that there is "nothing sustainable about southern California -- energy, water, or seafood," Schubel thought it would be the perfect place to create the kind of aquarium that he thought the nation and world needed.

Another perk of the location is the large number of research universities in the region. The abundance of scientific talent in the area offers the perfect opportunity for forming partnerships, something Schubel says the Aquarium of the Pacific relies heavily upon. While aquarium staff members are experts in packaging and distributing knowledge for the public, research scientists are the ones with expertise on the subject matter. With his vast experience in the academic research world, Schubel knows the key to effective partnerships is to make it easy for the researchers to get involved. "The benefits to them in terms of recognition by their peers, promotion, tenure…all those things…are modest. It's up to us in the free-choice learning world to figure out ways to involve them that are respectful of their time, that use it well, and that leverage their contributions."

With more and more funding agencies requiring grantees to conduct outreach, researchers are increasingly seeking new ways to get their science to the public. Schubel says forming partnerships with free choice learning centers is a win-win situation for both parties. And he practices what he preaches: several Ph.D. students from the University of Southern California are working on a new design for the Aquarium's "Plankton Corner." The students are providing the scientific knowledge and expertise, and the Aquarium will provide the funds to make their design a reality.

Although Schubel makes it a practice to approach researchers for input on exhibits, he acknowledges that not all institutions do. He advises that researchers interested in partnering "approach different levels of organization to find out where the resonance exists." He cautions that there's not any one answer to the question of how to get involved and notes that just as not all academics are interested in collaborating, not all staff in institutions want to collaborate with research scholars. In that regard, Schubel strongly encourages researchers to take advantage of existing networks such as the Centers for Ocean Sciences Education Excellence (COSEE - www.cosee.net) and the Coastal Ecosystem Learning Centers. Schubel points out that there are lots of networks out there whose purpose is to foster outreach: "there is no shortage of mechanisms to involve scholars in helping educate the public." The challenge, he says, is to execute and energize those networks by getting more scientists engaged.

For those who may be pondering a career in the free-choice learning world, Schubel advises a little bit of volunteering to see if it's really what you want to do. Volunteers are part of the lifeblood of these institutions, so there are plenty of opportunities. People can volunteer "as little as 2-4 hours per week – any days of the week." By volunteering, people can really find out what the culture is like in the institutions and see if it is a good long-term fit for them. And for those who want to get involved, he notes, "with so many science centers, natural history museums, and aquariums distributed around the country and around the world…for most universities, there's probably a place close by" where they can get involved.

Schubel believes that aquariums have a big role to play in influencing public opinion, and thereby public policy, on aquatic resources. "They are wonderful institutions and we've never quite reached our potential. So there's a lot to do. And I think we can play major roles in reframing some of these environmental issues in broader terms that will interest and engage the public." He adds that our message "can't just be about saving the last fish," it needs to be about people and ecosystems and how we're going to live sustainably on Earth. To Schubel, that's the exciting part of what these institutions can do.

REFERENCE

Falk, J.H., Reinhard, E.M., Vernon, C.L., Bronnenkant, K., Deans, N.L., and J.E. Heimlich, 2007. Why Zoos & Aquariums Matter: Assessing the Impact of a Visit. Association of Zoos & Aquariums. Silver Spring, MD.

ETHICS FORUM: WHISTLE-BLOWING IN SCIENCE

ASLO Professional Ethics Committee; ***Eric Weissberger,*** *Committee Chair, U.S. Environmental Protection Agency, Atlantic Ecology Division, 27 Tarzwell Dr., Narragansett, RI 02882 USA; weissberger.eric@epa.gov*

According to the American Heritage Dictionary, a whistle-blower is "one who reveals wrongdoing within an organization to the public or to those in positions of authority." Although whistle-blowing is often associated with organizational wrongdoing, it is individuals who actually commit wrongdoing. If one suspects a colleague of scientific misconduct, under what circumstances and how should the wrongdoing be brought to the attention of others?

First, someone who suspects a colleague of misconduct should have clear evidence, or at least firsthand experience, of the misconduct. Hearsay or indirect evidence may not be correct, and false allegations may injure not just the reputation of the one being accused, but that of the accuser as well.

Furthermore, the whistleblower should be aware of the intentions of the one he or she is accusing of misconduct. There is an ethical difference between unknowingly performing sloppy scientific work and knowingly conducting and publishing research that is scientifically unsound. Klotz (1998) lists a bill of responsibilities for whistleblowers in science, aimed at reducing unwarranted accusations of scientific misconduct. According to Klotz (1998), whistleblowers should have the knowledge to judge another's actions, be aware of potential biases and prejudices, and carefully examine their motivations. Does a whistleblower stand to benefit if the colleague in question is punished? Is he or she seeking revenge for poor treatment at the hands of the person being accused?

Once a person has examined the evidence, as well as his or her motivations, and is convinced that a colleague is engaged in misconduct, should the matter be brought to the attention of supervisors or the public? In some cases, a whistleblower might wish to confront the colleague directly. It is possible that the accuser is judging the colleague based on incomplete evidence. The person being accused should have the right to defend himself before allegations of misconduct are made to higher internal or external authorities. In many cases, however, the accuser may feel uncomfortable confronting the colleague directly, particularly if this person is a superior who may retaliate against the accuser. If an accuser fears revenge, he or she may wish to bring the matter to the attention of the supervisor of the person who engaged in misconduct. Bowie (1982, cited in Fisher et al. 1999) recommends exhausting all internal means to rectify the situation before involving external authorities.

Whistleblowers often face difficult ethical dilemmas. If they bring misconduct to light, they risk being ostracized at work, making for an uncomfortable environment and interfering with the ability to perform their jobs. There is also the very real possibility of whistleblowers being fired, and they must weigh bringing misconduct to light against providing for themselves and their family. Whistleblowers should also consider the results of their actions on the person they are accusing of misconduct. The person accused of misconduct may be fired, thus losing the ability to support his or her family. Is the misconduct egregious enough to put this person's career at risk?

These dilemmas are not solved easily, and each situation will be different. Before bringing charges of misconduct against a colleague, careful evaluation of the evidence and consideration of the results of public accusation are essential.

REFERENCES

Bowie, N. 1982. Business Ethics. Prentice Hall, Englewood Cliffs, NJ.

Fisher, J.E., W.B. Gillespie, E.F. Harshman, and F.C. Yeager. 1999. Whistleblowers on the web. Intellectual Property and Technology Forum at Boston College Law School. Available online at http://www.bc.edu/bc_org/avp/law/st_org/iptf/commentary/content/fisher_gillespie_etal.html.

Klotz, I.M. 1998. A bill of responsibilities for whistleblowers in science. FASEB Journal 12: 759-760.

MEETING HIGHLIGHTS

AQUATIC SCIENCES MEETING 2009: A MEMORABLE CRUISE THROUGH NICE WATERS

Peter Bossard, *EAWAG, CH-6047 Kastanienbaum, Switzerland, peter.bossard@eawag.ch;* ***Jean-Pierre Gattuso,*** *Observatoire Océanologique, Laboratoire d'Océanographie Microbial Ecology and Biogeochemistry Group, CNRS-UPMC, B. P. 28, F-06234 Villefranche-sur-mer Cedex, France, gattuso@obs-vlfr.fr;* ***Markus Weinbauer,*** *Laboratoire d'Océanographie de Villefranche (LOV), Microbial Ecology and Biogeochemistry Group, CNRS-UPMC, UMR 7093, BP 28, F-06234 Villefranche-sur-mer, France, wein@obs-vlfr.fr*

This article is dedicated to the late Prof. Ning Xiuren.

In January 2009 the third meeting outside North America was held on the lovely Mediterranean coast of Southern France. The large Centre de Congrès Acropolis (Fig 1), constructed on top of the river Paillon in downtown Nice is a masterpiece of modern architecture and an excellent venue to host 2,500 aquatic scientists from 60 countries, among them 750 students.

Approximately 1,400 ASLO members attended the meeting, and an additional 950 non-member scientists were also attracted by the exciting venue and meeting program. This was the largest

Figure 1. The Centre de Congrès Acropolis

ASLO meeting ever. An analysis of the geographical distribution of the participants nicely illustrates the past development of the former American, and, nowadays, global society, ASLO (Fig 2). More than half of the attendees originated from Western Europe and one fourth from North America. This also shows how important it is to hold ASLO meetings periodically in Europe. The hosting country, France, contributed 350 participants, followed by Germany (240), Spain (150) and the United Kingdom (140). This reminds us that the largest ASLO meeting prior to this, held in 2005 in Santiago de Compostela, Spain, attracted more than 2,000 scientists. Thus, Europe seems to receive ASLO meetings very well.

The organizational work for this meeting began in the fall of 2005 with a proposal submitted by the meeting co-chairs. Subsequent preparations followed with the professional assistance of the ASLO Business Office, headed by Helen Schneider-Lemay, a competent international scientific committee and a motivated local committee with representatives from different scientific institutions in Southern France.

ASLO President, Carlos Duarte, acknowledged the meeting in his closing thoughts by saying, "Nice has been, for a week, a friendly meeting point where aquatic scientists have interacted in presenting and discussing their results, which will evolve into new exciting research, research partnerships and friendships, all helping forge the bonds that will provide new impetus to aquatic sciences. All participants agree that the meeting was superb, in its organization, program and venue and I wish to congratulate the meeting co-chairs, their competent and enthusiastic committee, and the Schneider Group for this huge success, which I hope has compensated their many days of effort and hard work to prepare the meeting. Most of all, however, I wish to congratulate you, the participants, for it is your work that has provided the content of the meeting and the excellent science standards we all have enjoyed.

It is you also, who have provided a model for professional behavior and etiquette in the dialogs during question periods or at poster discussions, and your openness to discuss with all scientists present. The informal discussions at the meeting or while sharing breakfast, lunch, dinner, a glass of wine or simply coffee at one of the many wonderful cafés and restaurants in Nice have helped develop the networks that make us strong and that improve our science. As Mimi Koehl in her wonderful plenary lecture said, the opportunity to meet and discuss with scientists interested in problems and approaches different from yours is often a source of inspiration and discovery. The multidisciplinary nature of the meeting was a superb milieu to develop such interactions."

The committee had developed a scientific program that covered all topics in aquatic sciences. 1066 oral presentations were given in 100 different sessions that were held in 11 parallel events from Monday through Friday. Increasing emphasis was placed on poster sessions. A total of 939 posters were presented at various key locations of the Acropolis from Tuesday through Thursday.

Because this meeting was held on the Mediterranean coast, various sessions dealt with the Mediterranean Sea, e.g. about its biogeochemical processes and nutrient cycling, about signals of change, and the possible impacts of climate changes on its coastal regions (see write-up that follows).

Other important topics focused on global climate changes, bioengineering in oceans, pollution by trace metals, aquatic and sediment biogeochemistry, biodiversity and prey-predator interactions in aquatic ecosystems, as well as on current issues about international management of water resources to reduce eutrophication effects and water pollution.

Each morning a plenary session was devoted to a topic of broad interest:

- Will the open ocean become more or less stratified? – Implications for organisms and biogeochemical cycles.
- Is there a link between biodiversity and ecosystem function in aquatic systems?
- Should the freshwater carbon cycle remain hidden in the global carbon cycle?
- Can geo- (bio-) engineering of aquatic systems alleviate future climate change?
- Future water shortage and sustainable water management: their implications for aquatic ecosystems.

An innovative format was used: two speakers addressed the same topic with either opposing or complementary views and then engaged in discussion with the other speaker that was led by a moderator. ASLO past president Sybil Seitzinger commented, "I very much liked the two keynote presentations about a selected topic (complementary or controversial) and the subsequent panel discussion. The panel discussion, with questions prompted by the moderator, instead of questions from the audience, was very effective. I certainly think that trying different formats (such as the one referred to) at these meetings is a great idea and keeps the meetings fresh. It probably takes a lot more effort on the part of the meeting chairs,

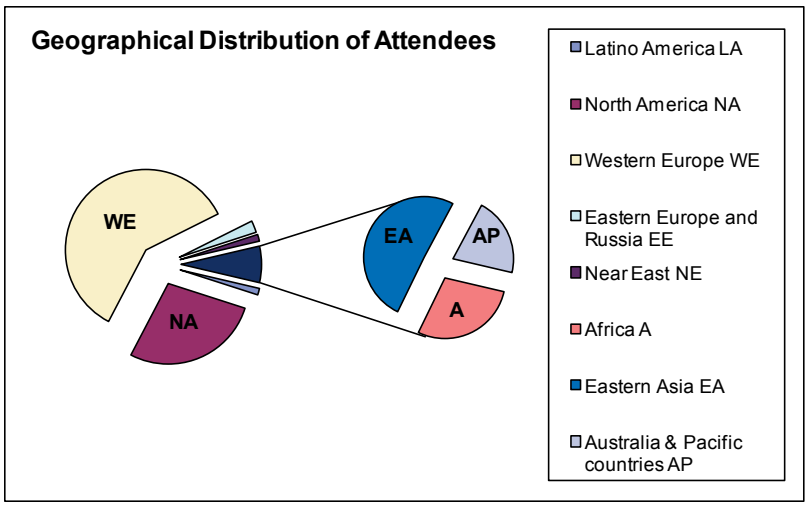


Fig. 2. Geographical distribution of participants

but then again gets the creative juices of the chairs flowing and puts a 'signature' on the particular meeting as well."

The following 16 topics (out of 100 topics) attracted more than 30 submitted contributions each and covered together 38% of the 2005 presentations (orals and posters) given in special sessions:

- Mediterranean and Black Sea: (94 abstracts): Biogeochemical processes, element cycling, primary productivity, carbon export and sequestration, and ecosystem functioning; Signals of change: Multi-Lateral Initiatives; Climate change effects on Mediterranean coastal ecosystems
- Stable isotopes in aquatic sciences (75 abstracts): Natural abundance stable isotope studies in aquatic biogeochemistry; Carbon and Nitrogen stable isotopes tracer studies in aquatic ecosystems
- Alpine, river and lake ecosystems (62 abstracts)
- Sediment biogeochemistry: advances in measurement and modeling (55 abstracts)
- Linking microbial communities to geochemical cycling (40 abstracts)
- Physical-biological interactions and the variability in coastal planktonic ecosystem dynamics (38 abstracts)
- Relationships among plankton community structure, ecosystem function and biogeochemical fluxes in the upper ocean (37 abstracts)
- Predator-prey interactions - linking mechanism to community dynamics (36 abstracts)
- Thresholds and regime shifts in aquatic ecosystems (36 abstracts)
- Ecology and diversity of aquatic protists: Advances and methodologies (36 abstracts)
- Experimental approaches to assess climate change impacts on marine phytoplankton (36 abstracts)
- Microbiology and biogeochemistry in oxygen-deficient water columns (34 abstracts)
- Organic matter export in the ocean, now and in the future (33 abstracts)
- Groundwater and surface water quality: effects of anthropogenic activities and climate change(32 abstracts)
- Aquatic biodiversity and ecosystem function (31 abstracts)
- A cruise through aquatic viral ecology (31 abstracts)

Figure 3. Co-Chairs (from left to right) Markus Weinbauer, Jean-Pierre Gattuso (OBS, Villefranche) and Peter Bossard (EAWAG, Switzerland) together with the Head of the ASLO Business Office, Helen Schneider Lemay, during one of the preparative meetings at the Acropolis Convention Center in Nice in 2006.

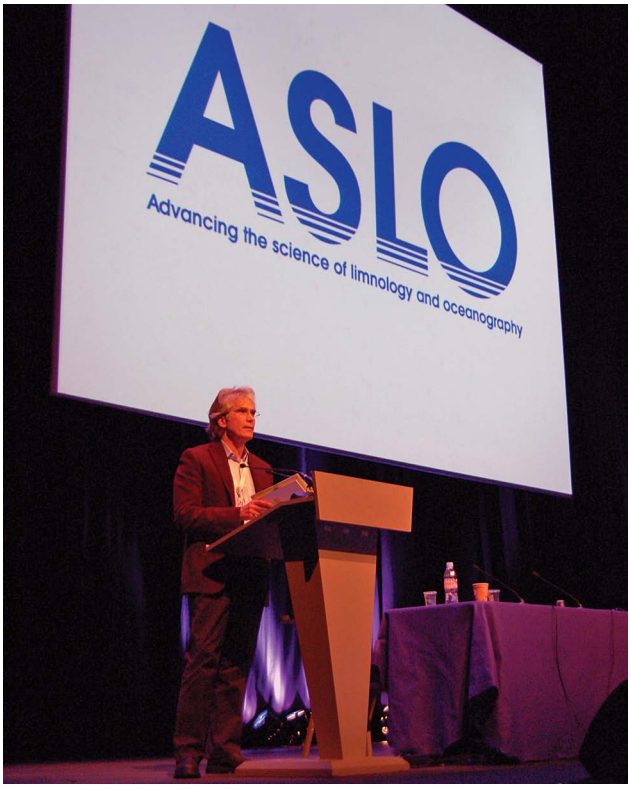


Figure 4. Meeting co-chair Jean-Pierre Gattuso speaking at a plenary session.

Figure 5. Attendees at a plenary session

While only three sessions (with 62 abstracts) were of purely limnological nature, 13 sessions (with 300 abstracts) dealt with purely marine topics. Thus, most session topics allowed the presentation of either limnological, marine or non-specified abstracts (> 80% of the presentations given) with a beneficial effect on the exchange of know-how between limnological and marine scientists. We've included summaries from some session chairs at the end of this article.

We hope that the bi-annual aquatic science meeting in Nice 2009 will encourage other scientists and institutions to continue the newly adopted habit initiated in Copenhagen in 2001 and followed by Santiago di Compostela in 2005, to frequently hold many more ASLO conferences outside North America helping to advance science in limnology and oceanography on a global scale.

SESSION SUMMARIES

064. Signals of Change in the Mediterranean and Black Seas - Multilateral Initiatives

Alessia Rodriguez y Baena *(arodriguez@ciesm.org), co-chair*

CIESM joined forces with the French CNRS and INSU in setting up this session focused on ongoing regional cooperation – the sharing of knowledge, tools, and experiences – among marine scientists from the Mediterranean and Black Seas. The session seems to have met a real success: the number of submitted abstracts was large, the scientific standards of the papers high, the geographic representation of the participants wide, and the audience broad and interactive.

There is no doubt that changes are impacting the Mediterranean Sea at a fast, unprecedented pace. This was well-reflected in the comprehensive overview on the spread of alien species in the region (B. Galil, Israel) and other instructive contributions on river inputs, ocean acidification, nutrient regimes and cycling, hydrodynamics, and ecosystem shifts *inter alia*. Junior scientists were not absent from the scene, providing stimulating elements for discussion, for instance, on long-term temperature variability in the Mediterranean (Y. Samuel-Rhoads, Cyprus) or on trends of zooplankton in the Black Sea (A. Nikishina, Russia).

A priority goal of our session was to promote synergies among marine scientists from various disciplines. *A posteriori* I can say: "mission accomplished." The pressing need for constructive basin-scale cooperation provided indeed the underlining theme of all presentations. These covered a variety of topics which ranged from the novel results stemming from the EU project SESAME (no less that eight abstracts), the description of harmonized national projects on long-term marine observatories (such as ELIOS and MOOSE) and the regionalization prospect of the French multidisciplinary program MERMEX.

The success of "Signals of Change – Multilateral Initiatives" well illustrates the importance for science of the Mediterranean Sea, a "miniature ocean" that offers a superb test-case to investigate marine processes and trends of global relevance.

018. Alpine Aquatic Ecosystems: Are they still nice waters?

Ruben Sommaruga *(Ruben.Sommaruga@uibk.ac.at), co-chair*

Mountains occupy 24% of the global land surface and the alpine region extends from 60° south to 70° north and thus, includes all the Earth's climatic zones. These characteristics make alpine waters important global sentinels for the early detection of climate change signals and their impacts on hydrological, ecological, and societal systems. The main objectives of the session were to examine the magnitude of ecological alteration of alpine waters at a global scale, to consider unrecognized threats, and to learn novel aspects of their ecology. The session largely fulfilled those expectations. The general consensus of the participants and of the audience was that talks and posters were of a homogenous good level and exciting. The tutorial presented a good overview of the different threats affecting alpine waters that range from acid rain to alkaline dust, from heavy metals to PCBs, from UV radiation to global warming, and from the invasion of aliens to conservation of endangered species. One arising threat was the recent finding of high nickel concentrations in alpine lakes of Central Europe, which exceed the limit for drinking water by more than one order of magnitude and that are related to the release of this heavy metal from rock glaciers as a consequence of climate warming. Other highlights were related with the role of Saharan dust intrusions as a dominant source of organic carbon to lakes in Sierra Nevada, Spain, the differential effect of nitrogen atmospheric deposition on phytoplankton observed in lakes saturated by nitrate (e.g., Central Alps) and those still limited by this element (e.g., some mountain regions of USA), the role of UV radiation in consistently explaining zooplankton vertical distribution in transparent alpine lakes, and a forecasting of 'winners and losers' macroinvertebrates taxa in response to climate warming. The effects of climate change were also a central topic in the sessions related to streams (# 62, 70) and other lakes (#90). Last but not least, poster presentations were well visited and one of them received the ASLO Award of Recognition

Peter Williams debating with keynote speakers.

(Differences in bacterial activity and composition of surface microlayer and underlying water in mountain lakes).

053. Sediment Biogeochemistry: Advances in Measurement and Modeling

Filip Meysman *(filip.meysman@vub.ac.be), co-chair*

Our session on sediment biogeochemistry carried the subtitle "advances in measurements and modeling." Being asked to reflect on the trends and highlights of the session wasn't an easy task. Even after giving the request some serious consideration, and playing the movie of the session again a few times over, I found it hard to single out a single presentation or poster among the parade of novel techniques and approaches that passed the review. Actually, this biodiversity in approaches was really the most striking feature of the session.

Just imagine how this same session would have been organized 20 years ago. Back then, the standard toolbox of the observational sediment biogeochemist consisted of some core sectioning tools, while the toolbox of the modeler would contain a lonely one-dimensional diffusion equation. Our session at the ASLO Nice 2009 meeting showed how much things have changed in the last two decades. The biogeochemist's toolbox now contains so many more toys. New sensor techniques have opened a new window on sediment biogeochemistry, providing an unprecedented view on the heterogeneity of the sediment. Some of these techniques are now in full swing, like the planar optodes to visualize the O_2 distribution in sediments in a two-dimensional way. Other techniques, like eddy correlation, are about to explode, and the first glimpses of this upcoming revolution could be sensed during the session. A similar trend is notable on the modeling side, where a whole new range of modeling techniques is now in use, including multi-dimensional fine-element modeling, continuous time random walks, and the coupling of sediment models to ocean circulation models. These are applied to tackle problems across a range of spatial scales, from phosphorus cycling in the global ocean floor, the pumping of water in tidal flat, the exchange of solutes across a sand ripple, and even to paint a detailed picture of the hydrodynamic regime inside the burrows of tiny midge larvae.

Poster Session

012. Stable Isotopes in Aquatic Sciences

Eric Boschker *(E.Boschker@nioo.knaw.nl), co-chair*

Stable isotopes have become increasingly popular in aquatic sciences. In every recent issue of *L&O*, a handful of papers can be found where stable isotopes were used to address a very diverse range of questions. It was, therefore, not surprising that the two dedicated stable isotope sessions at the ASLO Nice 2009 meeting, one dealing with natural variation and the other with tracer studies, had a very good response within a total of 75 abstracts.

The natural abundance session was organized along the aquatic continuum starting with contributions on lakes and small streams and ending in the oceans by the end of the day. Much of the freshwater work basically dealt with the question of what else besides phytoplankton was driving the aquatic carbon cycle and food web. There was, for instance, interesting work on the substantial abstracts from terrestrial and riparian organic matter, and on the methane subsidy to the aquatic food web. Although most of the presentations dealt with the usual suspect among the isotopes, there were also two talks on using silicon isotopes to study its sources and cycling in rivers and estuaries.

One of the beauties of stable isotopes is that you can actually take them to the field to study processes in their natural environment. There were a large number of *in situ* labeling studies in the tracer session dealing mostly with carbon and nitrogen cycling in coastal areas but also in far away places like

Awards Dinner. Members of the ASLO board chat with the ASLO award winners. From right to left: Austin Kemp; Paul Kemp (Yvette and Tommy Edmondson Distinguished Service Award); Ben Cuker (Ramon Margalef Excellence in Education Award); Mimi Koehl (Martin Award); Carlos Duarte, ASLO president; Susana Agustí, Carlos' wife and ASLO member; Mike Pace (G.E. Hutchinson Award); Marianne Pace, Mike Pace's wife; Lynn Abramson (senior student advisor); Kim Keats (student representative); John Downing (ASLO Award Committee chair); Alex Poulain (Raymond Lindeman Award); Richard Battarbee (Ruth Patrick Award); Debbie Bronk, ASLO president-elect; Peter Williams (Redfield Award); Teresa Coley, ASLO participant; Dawn Gerbing, Ben Cuker's wife; Susana Feng (Yvette and Tommy Edmondson Distinguished Service Award); Samantha Kemp.

the deep sea. A striking difference between the two sessions was the abundance of compound-specific isotope studies in the tracer session, which enabled researchers to also include the lower trophic, that is microbial levels, into their studies. Overall, we had a very good response and thank the many presenters for their interesting contributions.

MONACO DECLARATION ON OCEAN ACIDIFICATION

More than 150 leading marine scientists from 26 countries called for immediate action by policymakers to reduce CO_2 emissions sharply so as to avoid widespread and severe damage to marine ecosystems from ocean acidification. They issued this warning in the Monaco Declaration (http://ioc3.unesco.org/oanet/Symposium2008/MonacoDeclaration.pdf), released on 30 January during the ASLO meeting. The press conference was attended by ASLO President Carlos Duarte, James Orr, Denis Allemand and Jean-Pierre Gattuso.

The scientists noted that ocean acidification is already detectable, and that it is accelerating. They caution that its negative socio-economic impacts can only be avoided by limiting future atmospheric CO2 levels. Prince Albert II of Monaco has urged political leaders to heed the Monaco Declaration as they prepare for climate negotiations at the United Nations Climate Change Conference in Copenhagen this year. "I strongly support this declaration, which is in full accord with my efforts and those of my Foundation to alleviate climate change," he said.

The Monaco Declaration is based on the Research Priorities Report developed by participants at last October's 2nd international symposium on The Ocean in a High-CO_2 World, organized by UNESCO's Intergovernmental Oceanographic Commission, the Scientific Committee on Oceanic Research (SCOR), the International Atomic Energy Agency (IAEA) and the International Geosphere Biosphere Programme (IGBP), with the support of the Prince Albert II of Monaco Foundation and several other partners.

ASLO President Carlos Duarte speaks at press conference for the Monaco Declaration on Ocean Acidification

STUDENT ACTIVITIES AT THE ASLO AQUATIC SCIENCES 2009 MEETING

ASLO Student Representatives: ***Lynn Abramson,*** *Office of Senator Barbara Boxer, 112 Hart Senate Office Building, Washington, D.C. 20510;* ***Kimberley Keats,*** *Ocean Sciences Centre, Memorial University of Newfoundland, St. John's, Newfoundland, A1C 5S7, Canada; studentreps@aslo.org*

A number of student activities took place at the ASLO Aquatic Sciences Meeting in Nice, France, from January 25-30, 2009. These activities included four lunchtime career development workshops, student travel awards, a student social mixer, a career center, a book raffle, and outstanding student presentation awards. We would like to thank all those participants who helped make these events possible. A number of volunteer judges and session chairs evaluated the student presentations to select award winners. Michael Pace, Letise LaFeir, Brivaela Moriceau, Susana Agustí, Claudia Halsband-Lenk, Paul Renaud, Mikael Sejr, Jean-Éric Tremblay, Paul Wassmann, Everett Fee, and Paul Kemp participated as panelists in our student career development workshops. Elsevier, IMarEST, Oxford University Press, Springer, and Wiley-Blackwell kindly donated items for our student book raffle.

We would also like to recognize the winners of the outstanding student presentation awards at the meeting. Awards were given to the top 5% of student presentations as evaluated based on the clarity/effectiveness of presentation, quality of experimental design, clarity of conclusions, and innovation/scientific insight. Award recipients will receive a certificate of recognition and a $50 award from ASLO. Congratulations to all our winners!

ORAL PRESENTATION AWARD WINNERS

María Aranguren-Gassis
Rich Boden
Patricia Camara Mor
Raffaela Cattaneo
William Durham
Clement Fontana
Morten Iversen
Cornelia Jaspers
John Kirkpatrick
Julie Koester
Hagar Lis
Corinne Maurice
Danielle Morgan-Smith
Robinson Mugo
Renée Reilly
Virginie Riou
Kelly Robinson
Katherina Schoo
Tiffany Straza
Miriam Weber
Amanda Winans
Lars Wormer
Carmen Zayas-Santiago

POSTER AWARD WINNERS

Alexandra Barofsky
Paula Canal
Aubrey Cano
Antoine Carlier
Christine Cass
Claire Godinot
Paul Hoertnagi
Friederike Heinrich
Katrina Iglic
Eduardo Infantes Oanes
Cedric Javanaud
Amandine Lapoussière
Gisela Llaveria
Perrine Mangion
Sandra Marchandise
Hannes Peter
Kimberly Popendorf
Samuel Sturdivant
Cecile Rousseaux
Charles Vidoudez
Eugenia Zandona

ASLO NEWS

MESSAGE FROM THE PRESIDENT: MEMENTO FROM THE CÔTE D'AZUR

Carlos M. Duarte, *IMEDEA (CSIC-UIB); Miquel Marqués 21, 07190 Esporles, Mallorca, Spain; president@aslo.org.*

INCREASED OPPORTUNITIES FOR EARLY CAREER SCIENTISTS

The voting period to elect new members to the ASLO board is about to close as I write this message, and I hope that a majority of members have participated in this election. However, the recent trend has been toward a decline in the fraction of members that participate in the elections. Yet, this is arguably the single most important action that individual members can take to participate in the governance of ASLO. Voting is your opportunity to ensure that the board is representative of the constituency of the society, not only in that the members are elected, but in that they portray, in a balanced manner, the diversity of our society, in thematic orientation, gender, career stage and geography, among others. It is surprising that the percent of voting members is in decline despite the ease with which voting is now exerted: three minutes suffice to vote through ASLO's web page, compared to the more demanding process of voting by mail that was in place until just recently.

In addition to the election of board members, individual members can also participate in the governance of the society through service in one of many ASLO committees (see www.aslo.org/information/committees.html). If you would like to volunteer for any of the committees, please indicate so at the time you renew your membership in the appropriate place in the renewal form. You can also volunteer to serve on ASLO's committees by informing the business office (business@aslo.org) of your interests. Traditionally, members were invited by the board to serve on ASLO's committees through a top-down approach. However, this novel bottom-up mode of participation has been hugely successful since its introduction in 2008 and many members have now joined the committees they volunteered to serve. We encourage you to browse through the list of ASLO's committees, become acquainted with their charge and let us know in which of these would you be interested to serve.

At times of difficulty such as the present times of economic crises and rapid depletion of natural resources and deterioration of the environment, we need members to support the society and contribute their knowledge and capacities to improve our capacity to meet our mission. Science serves a particularly important role at a time when finding a new model to provide citizens with a high quality of life without deteriorating the environment. This challenge receives much of the attention of the world's leaders. The key role of science in the present situation is best portrayed by President Obama's statement, in his recent address to the National Academy of Sciences, that science is "more essential for our prosperity, our security, our health, and our environment than it has ever been." Far from being a rhetoric statement, President Obama substantiated his statement with the announcement that he is going to make major investments - 3 percent of the gross domestic product - in research and innovation. He emphasized the need to use these funds to promote high-risk research and to support researchers at the beginning of their careers.

We should celebrate this vision, which shares ASLO's vision for a key contribution of science to society and shares our perception of a particularly important role for scientists early in their careers. ASLO has made major efforts to support the needs of early career members and continues to expand its services and support to these members. Indeed, a major increase in resources for scientific research will drive a high demand for scientists early in their careers, from graduate students to young postdocs. This will not only occur in the U.S., as President Obama's announcement has already led to mirror movements in other regions of the world, such as Europe, to consider a significant increase in research funding. We must prepare to meet these challenges, and ensure that ASLO provides particular support to students, postdocs and early career scientists, through mentoring programs, such as the successful Ecological Dissertations in the Aquatic Sciences (EcoDas), career workshops, facilitating mobility, helping match job demand and supply in the aquatic sciences, and continue to run the best possible professional meetings to share the newest research. We are interested in hearing your ideas and thoughts as for additional programs and activities that ASLO could undertake to further serve early career members.

Carlos M. Duarte, ASLO President

MESSAGE FROM THE EDITORS OF THE *BULLETIN*

Adrienne Sponberg, *ASLO Public Affairs Office, P.O. Box 8785, Silver Spring, Maryland 20907 USA; and* ***John Dolan,*** *Marine Microbial Ecology, Station Zoologique, Laboratoire d'Oceanographie de Villefranche, Universite Paris6 CNRS UMR 7093, 06230 Villefranche-sur-Mer, France; bulletin-editors@aslo.org*

When we took over the helm of the *L&O Bulletin* in 2008, our goal was to expand the content of the *Bulletin* so that it more fully complimented our data-driven publications:

L&O and *L&O Methods.* Between the two of us, we have attended dozens of ASLO conferences, and we know that the members of this society are far more interesting than you can convey with graphs or statistics. You have stories to tell: about the history, the teaching, the conduct and the communication of aquatic science. Over the past six issues, we've included much of this information in the pages of the *Bulletin.* In this issue alone, you'll see that we have new recurring features, such as the "Beyond the Ivory Tower" column. We also have a variety of articles designed to make your professional life a little easier – ranging on topics from how to fund a proposal to teaching statistics using popcorn. And if you missed the meeting in Nice, you can still hear all about it in the wonderful summary written by the co-chairs, complete with summaries of some of the special sessions and lots of images.

We hope you are enjoying the new, expanded *Bulletin.* Your feedback is always welcome! In particular, we continue to look for articles that convey that "something extra" about aquatic science that makes our field so intriguing. If you have ideas for future articles or columns, please contact us at bulletin-editors@aslo.org.

MESSAGE FROM THE BUSINESS OFFICE

Helen Schneider Lemay*, ASLO Business Office, 5400 Bosque Blvd., Suite 680, Waco, TX 76710-4446; Tel.: 254-399-9635 or 800-929-2756, Fax: 254-776-3767; business@aslo.org*

Dear ASLO Member:

We hope that you have renewed your membership for 2009 – and are encouraging your colleagues to join or renew as well! Your membership allows ASLO to continue to be a strong and energized society and to keep providing benefits to you including exceptional journals and meetings. The web site (www.aslo.org) continues to add content and features. One of the newest is the availability of the plenary and award talks from the 2009 ASLO Aquatic Sciences Meeting in Nice, France. Now you can see and hear these wonderful talks online.

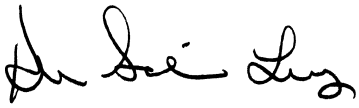
Our subscription base of libraries remains strong and if your library is not currently subscribing to the *L&O*, please encourage them to do so.

Meetings continue to be an exciting benefit of ASLO, and one of the goals of the society is to collaborate with other societies. This increases the dynamics of the science and networking as well as decreases the number of meetings that you might want to attend. In 2010, we will meet with AGU and TOS at the Ocean Sciences Meeting in Portland, Oregon, in February and, then, with NABS in June in Santa Fe, New Mexico. ASLO has also developed a policy to support efforts to reduce carbon imprints and make our meetings "green." These initiates will continue to grow and become an important part of our society culture.

We realize there will be times you have questions about your membership or need help with an ASLO issue, so it bears repeating the different ways you can contact the business office. We are readily accessible by e-mail: business@aslo.org, or you can call us at 800-929-ASLO (within the United States) or 254-399-9635. You also can fax a message to 254-776-3767.

As the society continues to grow, we look forward to serving more of you and assisting you with your individual needs.

From all of us at the ASLO Business Office,



Helen Schneider Lemay
ASLO Business Manager

L&O: KEEPING UP WITH CHANGING TIMES

Everett Fee, *Editor in Chief, and* ***Lucille Doucette,*** *Journals Manager; Limnology & Oceanography Editorial Office, 343 Lady MacDonald Crescent, Canmore, AB T1W 1H5, Canada, Voice: 403-609-2456, Fax: 403-609-2400; lo-editor@aslo.org, lo-manager@aslo.org*

Keeping abreast of current publication trends keeps us busy in the *L&O* Editorial Office. We'd like to give you some updates on things we've been dealing with over the past few years and particularly over the past six months.

L&O ON THE WEB

Timing of Web posting. Within a year after we started managing *L&O* in 1998 the journal was made available on-line. Up until now the PDF files of all papers in a new issue were posted on the Web at the same time (about two weeks before hard copy of the issue was mailed). Starting with Issue 4 of Volume 54 (July 2009) individual papers will be posted on the Web as soon as the printer has made final corrections, which for some papers could be up to four months sooner than in the past. This change is being made to bring *L&O* in line with the changing habits of readers. In pre-PDF days people read the tables of contents in hard copy to find articles of interest, while now they use Internet search tools (e.g., Google Scholar) to find relevant articles regardless of the journal or issue in which they appear (Jumars 2008). A consequence of this new way of finding literature is that *L&O* needs to be on-line as quickly as possible in order for the journal to remain attractive to potential authors and to serve readers most effectively. Note that special issues of *L&O* will continue to be available on-line under the old model—all at the same time, when the issue is complete—since SI's often include introductory articles and lead articles for topic sections, and the papers are usually grouped thematically.

Web appendices. *L&O* has never published appendices in the journal itself. But in 2003 (Volume 45, Issue 1) we began publishing electronic appendices. Even though these "Web Appendices" have been around for a while, we discuss them here because we have not previously described their intended use and it is clear that there is some misunderstanding about them.

L&O Web Appendices are reviewed as rigorously as *L&O* articles and are copyrighted by ASLO. Their purpose is to make available material that cannot be printed (e.g., videos) or essential data such as a table that would take up too much space in the journal. The reviewers and the associate editor must agree that the material in a Web Appendix is essential to understanding the associated *L&O* paper; i.e., Web Appendices are not intended to be a way to archive raw data or to make an *L&O* article shorter. Since there are many people who still read the printed journal, we try to minimize the need to go the Web to obtain essential information such as simple graphs or short tables that could be printed in the journal. We therefore have a strict policy of not allowing Web Appendices to be used for material that could reasonably be printed in the journal.

THE FORMAT OF *L&O* PAPERS

No Notes. One consequence of as-ready posting of individual papers on the Web is that *L&O* Notes cannot be grouped in a separate section at the end of each issue, as in the past. Further, the as-ready posting of papers on the Web undoes the primary *raison d'être* of the note format, i.e., making maximum use of *L&O's* limited pages by tailing-in notes (starting a new note on the same page where the previous one ended). Given the small number of papers we have been publishing in the note format (~5% of the total in recent years) and the incompatibility of this format with as-ready Web posting, we decided to combine the best features of both the article and note formats into a simpler one that will be used for all *L&O* papers.

The title page. Years ago most papers had only one or two authors and acknowledgments, if any, consisted of a few lines of text. Today things are very different: *L&O* papers are often the product of large research teams and the acknowledgments section frequently occupies a significant fraction (if not all) of the first column of text. In the last year, we published more than a few papers with more than 15 authors, and two with more than 30. When we received the page proofs for these latter articles and saw that it took more than 2 pages just to typeset the authorship, their institutional addresses, their present addresses, and the acknowledgments, we knew that the time had come to make some space-saving changes in the title page format, which has been virtually unchanged since Volume 1, Issue 1 (1956).

So starting with Issue 3 of Volume 54 (May 2009) the title pages in *L&O* will have a very different "look." Here is what has been changed: 1) All authors are listed in a single continuous string, with lettered footnotes indicating institutional affiliations and numbered footnotes indicating present addresses. 2) The acknowledgments have been moved to the end of the text, immediately before the list of references. 3) The e-mail address of the corresponding author is required and appears as an asterisked footnote. And, 4) street addresses of institutions no longer appear anywhere (does anyone still send snail mail?). As a result of these changes, the title page is now much more compact and altogether less "busy."

Associate editor. Another format change that discerning readers will have already noticed (it began in Issue 1 of Volume 54) is that the name of the associate editor who handled the paper is printed immediately after the references. This gives formal recognition to the significant input of these hard-working experts.

REPRINTS

Starting with Issue 4 of Volume 54 (July 2009), ASLO will no longer be involved with the order or delivery of hard copy reprints. All business regarding reprints will be done directly with the *L&O* printer (Allen Press). Allen Press has recently implemented digital printing, which allows them greater flexibility in producing reprints. Advantages of this new system are many: reprints can be ordered up to six months after publication at no additional cost, smaller numbers of reprints can be ordered, and the cost is about half of what it was in the past.

Another important consequence of outsourcing the production of reprints is that the ASLO Business Office will be able to issue invoices for publication costs as soon as the paper is posted on the Web (up to four months earlier than in the past).

REFERENCE

Jumars, P.A. 2008. Charting a course through the rip tides, cross currents, and undertows of scientific journal publishing. *Limnology and Oceanography Bulletin* 17: 2–8.

L&O FEATURED ARTICLE

Everett Fee, *Limnology & Oceanography Editorial Office, 343 Lady MacDonald Crescent, Canmore, AB T1W 1H5, Canada; lo-editor@aslo.org*

Beginning with the May 1999 issue of *Limnology and Oceanography*, selected articles have been made freely available for reading or download on the *L&O* web site a few weeks in advance of when the printed issue is mailed. Featured articles receive no special attention in the printed issue. A paper may be featured for different reasons (e.g., to draw attention to an exceptional piece of research or to promote an area of research that the associate editor feels *L&O* readers should be more aware of). Each featured article is announced in the *Bulletin*, as well as to the LO-Feature mailing list and is accompanied by an introduction to the article by the associate editor who handled the paper discussing its significance.

The featured article for the March 2009 issue of *L&O* is:

Davies, Andrew J., Gerard Duineveld, Marc Lavaleye, Magda J. Bergman, Hans van Haren, and J. Murray Roberts. 2009. Downwelling and deep-water bottom currents as food supply mechanisms to the cold-water coral *Lophelia pertusa* (Scleractinia) at the Mingulay Reef Complex. *Limnol. Oceanogr.* 54(2): 620–629.

This article can be read online at:
http://www.aslo.org/lo/toc/vol_54/issue_2/0620.pdf

Introductory Comments by Anthony Larkum (L&O Associate Editor)

Warm-water coral reefs are so eye-catching and visible—the Great Barrier Reef is said to be the only organic structure on the planet that can be seen from outer space—that we tend to

forget that there are coral reefs of a very different kind in deeper and colder waters. The featured paper in this issue of L&O draws our attention to these structures and presents vital clues as to how the many mouths of a deep-water coral community in the North Atlantic Ocean, dominated by the colonial scleractinian *Lophelia pertusa*, are maintained and fed.

Deep water coral reefs are found on continental shelves and slopes at depths below 100m, where there is not enough light to sustain algal symbionts, as is the case in tropical and subtropical coral reefs. Yet deep-water corals thrive: many reefs have been in existence over geological time-scales and have laid down carbonate mounds several hundreds of meters in thickness. An important question has been just how these deep-water corals obtain food. This is not an easy question to answer because their inaccessibility and the exposed nature of such sites has made direct observation for periods long enough to yield answers difficult.

Davies et al. used current meters and sensors on landers and moorings to obtain vital clues that address this question. Over two years, they studied currents, temperature, turbidity, and fluorescence at Mingulay Reef at a depth of 140 m in a relatively shallow strait between the Outer Hebridean Island chain and the Scottish mainland. This enabled them to determine particle supply to the coral community. They found that there are two major mechanisms for supplying organic particles to the hungry coral mouths. The first consists of a tidally-driven process that sucks surface water down to the coral community within an hour at the onset of ebb and flood tides. The second is the upwelling of deeper water, bringing with it a high load of suspended organic matter. These processes combine, usually at peak tides, to deliver particles to the reefs.

Deep-water reefs exist on canyons, slopes, and seamounts and in much deeper waters than this one. This study provides, for the first time, important clues as to how such communities depend strongly on the interplay between water flow and bottom topography to supply the food particles and larvae on which these communities depend.

OUTSTANDING *L&O* REVIEWERS

Everett Fee, *Limnology & Oceanography Editorial Office, 343 Lady MacDonald Crescent, Canmore, AB T1W 1H5, Canada; lo-editor@aslo.org*

Peer review is a crucial component of modern science. The fact that *L&O* is able to utilize the services of the best scientists as reviewers allows it to be a leading journal in the aquatic sciences. However, these individuals seldom get the recognition they deserve for this selfless work. Therefore, each issue of the *Bulletin* will cite outstanding reviewers that Everett Fee, *L&O* Editor, feels deserve special recognition for their overall reviewing efforts. The ASLO membership extends its sincerest appreciation and thanks these two outstanding scientist(s).

WILLIAM R. DEMOTT

Bill DeMott is a professor in the Department of Biology at Indiana-Purdue University. He does research on the pelagic food chains of lakes with a focus on mechanisms of food limitation in zooplankton. He is a member of the editorial boards of *Freshwater Biology* and *Aquatic Ecology*, has served terms as a subject matter editor for *Ecology* and as an editor for *Fundamental and Applied Limnology*, and has been an *ad hoc* reviewer for at least 31 scientific journals.

HANS-PETER GROSSART

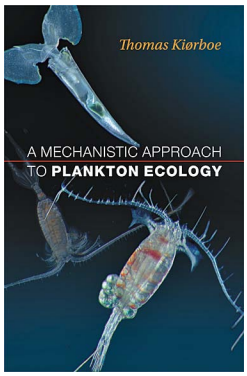
Hans-Peter Grossart is a scientist at the Department of Limnology of Stratified Lakes, Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB-Berlin) where he is leading the research section for "Aquatic Biodiversity" and the "Aquatic Microbial Ecology" group. His research interests are broadly in marine and freshwater ecology, focusing on biogeochemical processes such as C-cycling and Poly-P storage in the pelagic zone and sediments, interactions between bacteria and other organisms, diversity and function of aquatic microorganisms, and aggregation processes. At present, his group is investigating diversity, evolution, and ecological functions of pelagic freshwater bacteria, in particular *Actinobacteria* of the Ac groups, in a variety of different lakes but also in the Baltic Sea. Other research topics include microbial humic matter degradation, fungal ecology, photolysis of microbial substrates, ocean acidification, and temperature dependent changes. His group combines traditional microbiological methods with molecular methods and chemical analytics to unravel the fascinating mystery of aquatic microbes at the microscale of specific aquatic habitats up to the global scale.

BOOK REVIEWS

THOMAS KIØRBOE. 2008. **A Mechanistic Approach to Plankton Ecology**. Princeton University Press. ISBN: 978-0-691-13422-2. 228 p. US$39.50.

Reviewed by ***Jef Huisman,*** *Aquatic Microbiology, Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, Nieuwe Achtergracht 127, 1018 WS Amsterdam, The Netherlands; j.huisman@uva.nl and* ***Sophie Rabouille,*** *Laboratoire d'Océanographie de Villefranche (LOV), UMR 7093, Station Zoologique, B.P. 28, 06234, Villefranche-sur-mer, France; srabouille@obs-vlfr.fr*

Kiørboe's book offers an exciting tour through biological-physical interactions in the plankton. The book successfully demonstrates how basic knowledge of small-scale physical and chemical processes contributes to a better understanding of plankton ecology at the individual level. Expanding on these individual-level processes, the book produces new insights in community dynamics, and the structure and functioning of pelagic food webs. It is an outstanding overview of ongoing research on plankton encounter rates, and will be highly suitable for seminars and advanced student courses.



The first chapters present an invitation to think about notions at the core of plankton ecology. Kiørboe leads the reader through a variety of ideas and fundamental questions to develop an intuitive understanding of the everyday life of individual plankters. At the individual level, the life of planktonic organisms is all about encounters. They have to find food, they have to find mates, and they should stay away from predators. These might seem simple and familiar tasks. After all, human beings also enjoy a good dinner, like to find a good mate, and prefer to avoid any undesired encounters. Yet imagine yourself as a tiny little plankter in the middle of the endless ocean, mostly blind-folded. The surrounding fluid is three-dimensional, concentrations of food are extremely low, and the nearest mate can be thousands of body lengths away. In addition, the surrounding fluid feels like dense syrup as the viscosity of water dominates over inertial forces at these small scales. Swimming is demanding. Got the picture? How are you ever going to arrive at dinner in time, let alone find yourself a suitable mate in this unstructured, viscous and vast environment? The ocean environment as experienced from the perspective of a small plankter isn't quite the same as our own world after all.

Natural selection has favored a multitude of adaptations in the individual behavior, morphology, and ecology of planktonic organisms to cope with these challenges. Take the copepods, which make up about 80% of the mesozooplankton in the oceans. As nicely illustrated on the front cover of the book, copepods have two huge antennules packed with sensory hairs sticking out in the water, aimed at chemical and hydromechanical signals in the environment. They put this sensory machinery into use to explore their surroundings. For instance, female copepods can leave a long trail of pheromones behind as they slowly swim through the endless ocean. Male copepods crossing this trail pick up the scent, and track the convoluted trail. During tracking, the male constantly checks the borders of the trail by chemoreceptive sensors on its antennules, and adjusts its chase accordingly, until he finally makes it to the female. Kiørboe discusses these spectacular stories in a very lucid style, and then moves on to derive equations that allow a quantitative evaluation of the implications. For instance, based on simple calculus, he shows that pheromone tracking increases the encounter rates of males and females substantially. Girls shouldn't leave without a trace.

These analyses point to the issue of spatial scale. Do we observe plankton dynamics at scales relevant to the organisms? Much of our knowledge of aquatic ecosystems is based on "blind sampling," where we simply scoop up a few liters of water, several meters apart along the vertical, and enumerate the organisms in our samples. However, these coarse methods only sample bulk properties of aquatic ecosystems. Kiørboe argues, convincingly, that these sampling methods exceed the spatial scale of individual plankters by orders of magnitude. The whole book builds up on this logic. It starts from descriptions of the spatial and temporal scales at which chemical signals and food particles are dispersed by diffusion and advection, and shows how these important transport processes affect the feeding rates and motility of individual organisms. Subsequently, Kiørboe discusses the emergence of global properties at larger scales, extrapolating the individual-based processes from preceding chapters to the population level. For instance, according to the coagulation theory developed with his colleague George Jackson, encounters between sticky particles can ultimately lead to the formation of large aggregates in the form of marine snow. Such aggregate formation has important implications for the dynamics of phytoplankton populations, which suffer large sedimentation losses by coagulation, and for the downward flux of organic carbon from surface waters into the deep ocean. Finally, in the last chapter of the book, the individual- and population-level processes are integrated to gain a more comprehensive understanding of the dynamics of entire pelagic food webs.

Emphasis is clearly set on processes at the organism scale. Hence, the chapters on community processes and ecosystem dynamics are relatively brief, and the book does not cover all aspects of plankton ecology. In particular, the title of the book may suggest that it covers mechanistic approaches to competition theory, which is textbook material in many undergraduate ecology courses, and has been extensively tested in plankton competition studies (e.g., papers by Tilman, Sommer, Grover, Rothhaupt, Lampert, and several others). However, although the book contains many useful references to competition studies, the book does not review resource competition theory, and also doesn't tackle several other hot topics in plankton ecology such as ecological stoichiometry, inducible defenses, biogeochemical processes, and regime shifts in aquatic ecosystems. The book is more limited in scope than the title suggests. Clearly, dealing with all these topics would have been a tremendous task, and would have diluted the original message of the book in a mass of information. The book may thus present a starting point for plankton ecologists, to inspire further research linking the small-scale physical processes that are so important in the everyday life of the plankton with other important themes in plankton ecology. The intended audience of the book consists of graduate students and postdocs as well as senior researchers. Some understanding of biological oceanography and/or aquatic ecology, at the undergraduate level, is recommended. Many of the conceptual ideas build on earlier books on physical-biological interactions by Denny (1993), Berg (1993), and Vogel (1994). However, none of these earlier books focused specifically on the plankton. The author makes extensive use of simple fluid dynamics and diffusion theory to understand and evaluate the adaptations of planktonic organisms to their physical and chemical surroundings. Hence, mathematical equations are presented throughout the book. Yet, the math never becomes really complicated. A basic knowledge of high school calculus is required, and is often (but not always) sufficient to follow the arguments. It is clear from the careful explanations that much of the material has been developed as teaching material for courses. The writing style is very pleasant and reveals a passionate author, who offers his thoughts, and shares his experience, in a very didactic synthesis. Last but not least, the book is affordable (only US$ 39.50!). If you are interested in the state of the art on life at the scale of the individual plankter, then this book is definitely something for you!

REFERENCES

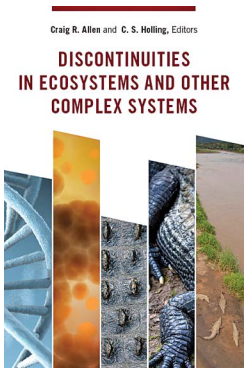
Berg, H.C. 1993. Random Walks in Biology. Princeton University Press, Princeton.

Denny, M.W. 1993. Air and Water: The Biology and Physics of Life's Media. Princeton University Press, Princeton.

Vogel, S. 1994. Life in Moving Fluids: The Physical Biology of Flow. 2nd ed. Princeton University Press, Princeton.

CRAIG R. ALLEN AND C.S. HOLLING (Eds.) 2008. **Discontinuities in Ecosystems and other Complex Systems.** Columbia University Press, New York. ISBN 978-0231144445. 288 p. US$84.50

Reviewed by ***Marten Scheffer,*** *Aquatic Ecology and Water Quality Management Group, Wageningen University and Research Center, PO Box 8080, NL-6700 DD Wageningen, The Netherlands, Marten.Scheffer@WUR.NL*



Known for his seminal work on the functional response and resilience, C.S. Holling in 1992 published a paper (Holling 1992) that would again stir up the field of ecology. He showed that the distribution of body size in ecological communities might not follow the classical smooth power-law, but rather show a puzzling regular pattern of 'lumps' and 'gaps.' Analyzing data from birds and mammals he found that there were groups of species of roughly the same size (the lumps), whereas other sizes in the possible range were conspicuously missing (the gaps). While there was initial doubt about the statistical significance of the lumpy patterns, later studies in terrestrial but also in aquatic communities (e.g. Havlicek and Carpenter 2001) suggest that the lumpiness might actually be a quite common feature of size distributions.

Clearly, this pattern is fascinating as (unlike standard distributions) it might hint at underlying mechanisms that shape communities. The overall explanation suggested by the editors is introduced in the very first sentence of Chapter 1: "We describe the organization of ecological systems as […] hierarchically arranged, mutually reinforcing sets of processes that operate at different spatial and temporal scales, with all levels subject to an adaptive cycle of collapse and renewal, and with levels separated by discontinuities in key variables." While the lumpy patterns were received with some reservation, this associated worldview has created perhaps more resistance in the ecological community. In an effort to push the field further a meeting of proponents and skeptics was organized at the Santa Fe Institute in 2001, providing the foundations for most of the chapters in the book, highlighting the issue from diverse angles.

One of the most fascinating reads is the synthesis chapter by Donald Ludwig in which he ponders the evidence, but also allows the reader a rare look behind the screens. Ludwig interviewed some of the participants to the meeting, amongst those one of the most outspoken critics, Jim Brown, who in an email quoted in the chapter wrote: "I am concerned that Buzz [Holling] wants the community to buy into his complete worldview." Another participant, Brian Maurer, wrote after the meeting: "The lack of mechanistic explanations […] I think limits the usefulness of the lump/gap concept […]. As yet, I have not seen many, if any, general synthetic theories that can be used to predict the existence of hierarchical structure in ecosystems."

I think it is wonderful that the editors made these doubts visible in the book. It more-or-less characterizes where the field is: There are intriguing lumpy patterns in various body-size distributions (as well as in other characteristics such as range sizes), but the explanation is still rather open. This points the reader to two kinds of follow-up efforts. Firstly, we should explore how common such lumpy patterns really are. For those interested in pursuing this track, the book points the reader towards useful approaches to scan for patterns and provides examples of applications. Secondly, the existence of a pattern with no obvious explanation is an exciting opportunity to test theories and invent new ones. Several potential explanations are evaluated in the book ranging from slow evolution and size specific predation to the central idea that landscape patterns somehow impose body-size patterns. My own favorite explanation is yet another one: the lumpy patterns may be caused by two alternative ways for species to co-exist: being sufficiently different (allowing niche separation) or being sufficiently similar (allowing neutral coexistence within the lumps) (Scheffer and Van Nes 2006). Perhaps there are other potential explanations that nobody thought of. Certainly we need inventive approaches to sort out between such ideas.

In summary, the book introduces the reader to a field in which there are puzzling patterns but no consensus on their explanation. Aren't such fields of work the best places to be?

REFERENCES

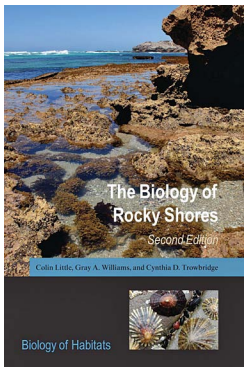
Havlicek, T.D., Carpenter, S.R. 2001. Pelagic species size distributions in lakes: Are they discontinuous? Limnology and Oceanography 46:1021-1033.

Holling, C.S. 1992. Cross-scale morphology, geometry, and dynamics of ecosystems. Ecological Monographs 62:447-502.

Scheffer, M., Van Nes, E.H. 2006. Self-organized similarity, the evolutionary emergence of groups of similar species. Proceedings of the National Academy of Science, USA. 103:6230-6235.

COLIN LITTLE, GRAY A. WILLIAMS AND CYNTHIA D. TROWBRIDGE. 2009. **The Biology of Rocky Shores, 2nd edition.** Oxford University Press. ISBN 978-0198564904. 352 p. US$120

Reviewed by ***Pascal Riera****, Station Biologique de Roscoff, UPMC Univ Paris 06, CNRS UMR 7144 AD2M, Place Georges Teissier. 29682 Roscoff Cedex. France, riera@sb-roscoff.fr,* ***Ann Andersen****, Station Biologique de Roscoff, UPMC Univ Paris 06, CNRS UMR 7144 AD2M, Place Georges Teissier. 29682 Roscoff Cedex. France, andersen@sb-roscoff.fr, and* ***Dominique Davoult****, Station Biologique de Roscoff, UPMC Univ Paris 06, CNRS UMR 7144 AD2M, Place Georges Teissier. 29682 Roscoff Cedex. France, davoult@sb-roscoff.fr*



The second edition of the Biology of Rocky Shores gives a worldwide overview of the rocky sea-shore landscapes, with its particular flora and fauna. It aims to explain how environmental factors and species interactions structure these marine communities, and shape population distributions. It also deals with the possible changes resulting from natural or human impact. Compared to the first edition, most of the themes have been enhanced and developed as separate chapters. New topics are taken up such as: the adaptations of organisms to life on shore, the effect of hidden parasitism on community structure, and the impact of climate change, to name just a few. Nice and easily understandable examples are presented from the literature.

Chapter 1 constitutes a classical presentation of the shore environment, close to the one of the first edition. Tides are described and the problems of emersion and wave exposure are considered. One can regret that the variability of tidal phenomena are not taken into account at the biosphere scale, but rather only with regard to the coasts of the North Atlantic.

Chapter 2 addresses marine biodiversity through descriptions of distributions along vertical scales, according to waves and tides, and the latitudinal scale, according to climate. It describes the diversity of the nutritional guilds in a detailed and interesting way. As the second edition has an extended scope, relative to the first edition, from temperate areas to a broader worldwide overview of rocky shores, it is perhaps regrettable that symbiotic nutritional pathways were not been considered, although this is common if not dominant in the hard substrates formed by the corals in tropical waters.

Chapter 3 deals with the adaptations of organisms on rocky shores: how they cope not only with desiccation, water currents and breaking waves, but also their life history strategies to ensure larval settlement and to maintain their population in the environment.

Chapter 4 which deals with primary producers is well structured and includes new references. The diversity and distribution of primary producers are presented as well as their role as habitats, their productivity and their function as sources for associated food webs.

The complexity of trophic interactions is well documented in Chapter 5 based on detailed descriptions of anatomical and physiological characteristics in relation with the ability of animals to use a variety of food items within macroalgal assemblages. The grazer-algae relationships are nicely illustrated through experimental and behavioural approaches. Detailed descriptions of field experiments are provided to illustrate feeding behaviour and adaptative properties for species acting both as consumers and preys. The consequences of interspecific relationships in terms of community structure and stability of the trophic network are also discussed. However, more emphasis on recent chemical insights involved in grazer-algal interactions could have been included.

Chapter 6 describes the anatomical and physiological mechanisms specific to various taxonomic groups, thereby introducing the ecological effects of suspension feeders on physical and biological properties of the surrounding habitats (for example, via excretion of nutrients). The problems linked to settlement and metamorphosis on hard substrates or seaweeds are explained on the basis of the life history of several species. This point is well documented from recent studies. However, insights related to food selectivity by filter feeders are curiously missing, despite the fact that an abundant literature is available.

In Chapter 7, the variety of feeding mechanisms and strategies developed by predators, from invertebrates to birds and mammals, are described. Remarkable descriptions of predatory behaviour are given in relation with biological (parasites) or physical (wave exposure) influences.

Chapter 8 concerns vertical distributions and is a rearrangement of Chapter 2 of the former edition. Vertical distribution is described from a classical point of view, and no important change or addition of references occurred.

Chapter 9 explains the consequence of wave exposure on the structure and the functioning of rocky shores. Again, the treatment is very classical and very close to the one in the first edition, with no real additions.

Chapter 10 describes how biotic and abiotic factors, from sheltered to exposed shores, act to structure communities. Many illustrations based on field experimental studies and observations involving keystone species are shown. Within a rocky shore habitat, the determination of "strong" trophic interactions is essential because of their essential role in sustaining food web structure and stability, in contrast to "weak" interactions. This important question is, however, not well enough illustrated through recent food web representations based on measurements of the most relevant interactions.

Chapter 11 focuses on the consequences of human influences on rocky shores. It lists the main chemical wastes: oil spill, TriButylTin (antifouling paint) and eutrophication… with some possible responses to this type of pollution. Physical disturbance such as trampling effects, over-fishing and by-catch, alien invaders, and climate change are considered too. This chapter concludes with approaches to marine conservation, and underlines the importance of the size and number of protected areas, enabling connectivity, which maintains marine biodiversity.

Chapter 12 is new and quite original: it is a description of several methods and experimental approaches that formerly were included in within different chapters of the first edition. Some new methods are also added. It seems a good idea to create a separate chapter, especially for students who always need clear explanations on the practical aspects of marine ecology.

Overall, the book is a delightful piece of work, well documented, with more than 500 references. The text is easy to read and gives a straightforward synthesis of current scientific knowledge. Its conciseness, key-references and many diagrams, make it a goldmine for teachers of marine ecology.

2009 Tyler Prize

Professor Richard B. Alley

Evan Pugh Professor of Geosciences
The Pennsylvania State University

Professor Veerabhadran (Ram) Ramanathan

Distinguished Professor of Climate
and Atmospheric Sciences
Scripps Institution of Oceanography
University of California, San Diego

Tyler Prize

The Tyler Prize was established in 1973 by the late John and Alice Tyler as an international award honoring achievements in environmental science, policy, energy and health of worldwide importance conferring great benefit on humanity. The Tyler Prize consists of a cash award of $200,000 and a gold Tyler Prize medallion.

For additional information on the 2009 award or nomination procedures for 2010 contact:

Sue M. Anderson, Administrator, The Tyler Prize
Phone (213) 740-9760 • Fax (213) 740-1313
Email: tylerprz@usc.edu • Home page: www.usc.edu/tylerprize

The Tyler Prize Executive Committee announces the awarding of the 2009 Tyler Prize for Environmental Achievement on its thirty-sixth anniversary to Professors Richard B. Alley and Veerabhadran (Ram) Ramanathan, for their scientific contributions that advanced understanding of how human activities influence global climate, and alter oceanic, glacial and atmospheric phenomena in ways that adversely affect planet Earth.

Richard B. Alley is recognized for his contributions to understanding the relationships between the cryosphere and global warming, the vulnerability of the Antarctic and Greenland ice sheets, and for alerting us to the potential for contemporary abrupt climate change and its possible impacts and costs to society today.

Veerabhadran (Ram) Ramanathan is recognized for his contributions to the understanding of the dangers to planet Earth, especially from perturbations to its radiation field by trace greenhouse gases, and illumination of how significant regional impacts to humans can be caused by the aerosols in atmospheric brown clouds.

Web: www.geosc.psu.edu/people/faculty/personalpages/ralley/
www-ramanathan.ucsd.edu/

Recent Laureates

2008 James Galloway and Harold Mooney, for Human Impact on Ecological and Global Biogeochemical Processes
Previous awardees: www.usc.edu/dept/LAS/tylerprize/previous.html

Tyler Prize Executive Committee

The Tyler Prize is governed and awarded by the independant Tyler Prize Executive Committee www.usc.edu/dept/LAS/tylerprize/execcomm.htm, and administered by the University of Southern California.

Dr. Owen T. Lind, Chair, *Baylor University*
Dr. Rosina M. Bierbaum, *University of Michigan*
Margaret Catley-Carlson, O.C., *World Economic Forum Global Council on Water*
Dr. Robert A. Frosch, *Harvard University and Woods Hole Oceanographic Institution*
Dr. Arturo Gómez-Pompa, *University of California, Riverside and Universidad Veracruzana*
Dr. Judith E. McDowell, *Woods Hole Oceanographic Institution*
Dr. Ralph Mitchell, *Harvard University*
Dr. F. Sherwood Rowland, *University of California, Irvine*
Dr. Jonathan M. Samet, *University of Southern California*
Dr. Cornelius W. Sullivan, *University of Southern California*

On June 6, 2010, hundreds of aquatic scientists of many nationalities from two major scientific societies will rendezvous on Santa Fe, New Mexico to share and discuss their latest findings. The global water resources that these scientists study face inordinate challenges. The year 2010 marks the 400th Commemoration of Santa Fe as a capital and cultural center.

Important Dates

Session proposals must be submitted on-line by **23:59 U.S. Central Daylight Time, 30 September 2009**.

The Call for Abstracts will be issued **early Fall 2009.**

Abstracts will be due on-line **12 February 2010.**

AQUATIC SCIENCES: GLOBAL CHANGES FROM THE CENTER TO THE EDGE

During these past four centuries, a limited supply of water has been a precious hydrological lifeline in this area of the U.S. The 2010 ASLO-NABS meeting's theme, Global Changes from the Center to the Edge, draws attention to the entirety of aquatic systems on which humans depend. Lakes and ponds have centers that respond to influences from the nearshore and the watershed as do oceans. Science too has centers of scholarship and associated interdisciplinary activities. This meeting will explore these and other centers and edges, encompassing and embracing the entire hydrological cycle and drawing strength from the synergy to be found between the North American Benthological Society and the American Society of Limnology and Oceanography.

2010 Summer Meeting

Joint Meeting with ASLO & NABS

June 6-11, 2010 · Santa Fe, New Mexico, USA

www.aslo.org/santafe2010

Meeting Co-chairs

Bob Sterner
University of Minnesota
stern007@umn.edu

Michael Barbour
Tetra Tech, Inc.
michael.barbour@tetratech.com

Shelley Arnott
Queen's University
arnotts@biology.queensu.ca

Jim Thorp
University of Kansas
thorp@ku.edu

Committee

Jay Austin
University of Minnesota
jaustin@d.umn.edu

Michelle Baker
Utah State University
mbaker@biology.usu.edu

Lucinda Johnson
University of Minnesota
ljohnson@d.umn.edu

Judy Li
Oregon State University
judyli@comcast.net

Michael Twiss
Clarkson University
mtwiss@clarkson.edu

Local Organizers

Anna Hamilton
Tetra Tech, Inc.
anna.hamilton@tetratech.com

Jerry Jacobi
drsjacobi@cybermesa.com

ASLO
Advancing the science of limnology and oceanography

L&O BULLETIN

5400 Bosque Boulevard, Suite 680
Waco, Texas 76710-4446

ASLO