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Dynamism Is the New Stasis: Modern Challenges for the Biological Sciences

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Technological advancements in recent years have completely overhauled how the scientific community communicates, discovers, creates, and connects. In addition, the field of biology has become increasingly interdisciplinary, exploding with novel information that has necessitated boundary-pushing collaboration and required new ways of communicating. These two changes combined have radically altered social norms and expectations within the professional community of biologists. As Price (2012) put it, "Science is in the process of being re-built and transformed. It is going to be an exhilarating process. The positive impact [on] society will be significant."

Beyond the changes in individual professional activities, there is also compelling evidence that the relationship between individuals and their professional societies is changing dramatically. An understanding of this relationship shift is important for two reasons: Scientists and students rely on their professional societies to connect with a peer network that will vet and strengthen their research and advance their careers, and these organizations rely on individuals to contribute their expertise and time to fulfill a critical role in advancing the science. If professional societies are to continue filling these niches and providing key social services not offered by academic institutions or government agencies, a better understanding of the changing dynamics between individuals and their scientific organizations is required in order to help meet these goals and advance the scientific endeavor.

AIBS's own observations of changing membership dynamics prompted a focused effort to gain deeper insights into emerging trends and their potential impact on the life sciences field and profession. Our work began in 2009, as we looked at AIBS's historical and current membership patterns. To understand the broader dynamics influencing these patterns, we surveyed representatives of other biological sciences organizations, individual biologists, and biology students. These surveys were followed by research and consultation with professionals in the association-management industry. Most recently, we created a database of societies and associations to understand the organizational landscape that supports the biological sciences community.

The present article provides highlights from some of our earlier work and reports the insights gleaned from our most recent study. Our goal is to share information that will strengthen the dialogue about the biology research community, how it has changed over time, and the role of its scholarly societies in ensuring the vitality of the field in the twenty-first century.

Surveys of biological organization leaders

AIBS conducted two surveys of biology organizations in 2010 and reported the survey findings in *BioScience* in April 2012 (Musante and Potter 2012). The article revealed what we had learned from biology organization leaders about the role of their member-based organizations, the nature and number of the programs that they administered, and what they perceived as the greatest challenges facing the field of biology as a whole. The changing financial, sociocultural, and technological forces of the twenty-first century, as well as the changes in how we conduct science, are affecting scholarly societies, and these effects were expressed by our survey respondents. The responses pointed to concerns about membership, funding, and journal sales and publication as the three greatest challenge areas facing biology organizations. These three issues are inextricably intertwined, because delivering a high-quality research journal to a membership base has been the foundation of many scholarly societies' business models for decades. New points of value and an understanding of and responsiveness to the changing environment in which we operate will

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be required in order to ensure the sustainability and relevance of scholarly organizations to their members.

A survey of individuals in the biological sciences

In 2010, AIBS administered a survey for individuals and received responses from more than 4300 professional biologists and biology students, the results of which were reported in full online at *https://aibs.site-ym.com/page/Index/?*. In the report, the responses are examined in seven career segments: undergraduate and graduate students; postdoctoral scholars; early-, mid-, and late-career professionals; and retired professionals. The survey questions explored the motivations, challenges, and priorities of the respondents in addressing their personal professional needs, how they related to scholarly organizations, and what they perceived as the greatest challenges to the field of biology.

The results confirm that journal access is not the most compelling motivation for joining an organization, regardless of an individual's career stage. The two most compelling reasons for someone to join a professional organization are to attend a meeting face to face and to be part of a professional community. Although these motivating factors were consistent, the survey also uncovered the changing interests and priorities of each career stage. Efforts to recruit or engage professionals should consider the specialized needs and interests of individuals at their current career stage in order to be successful.

Efforts to recruit members should also be realistic with regard to the limitations that individuals have on how many organizations they join and how much time and how many resources they can invest in society activities. We found that individuals were very selective and chose to join a limited number of professional organizations. A majority of the respondents in the first five career segments joined only 1–3 societies. Mid- and late-career professionals were only slightly more likely to join a higher number of organizations (4–8 organizations). This suggests that organizations need to be attuned to the fact that, although there are many individuals actively joining professional societies, they are being very selective in determining which communities warrant their personal investment of time and resources.

Greatest challenges facing the field of biology

Both 2010 surveys had one question in common: *What are the greatest challenges facing biology?* The respondents were asked to select 3 choices from a list of 19 as defined by AIBS staff members or to add their own challenge in a text box. A multisegment analysis comparing responses across career stages, professional environments, and discipline types demonstrated that the following were the greatest challenges facing biology: the public's lack of appreciation for biology and decisionmakers' not being informed about issues (figure 1).

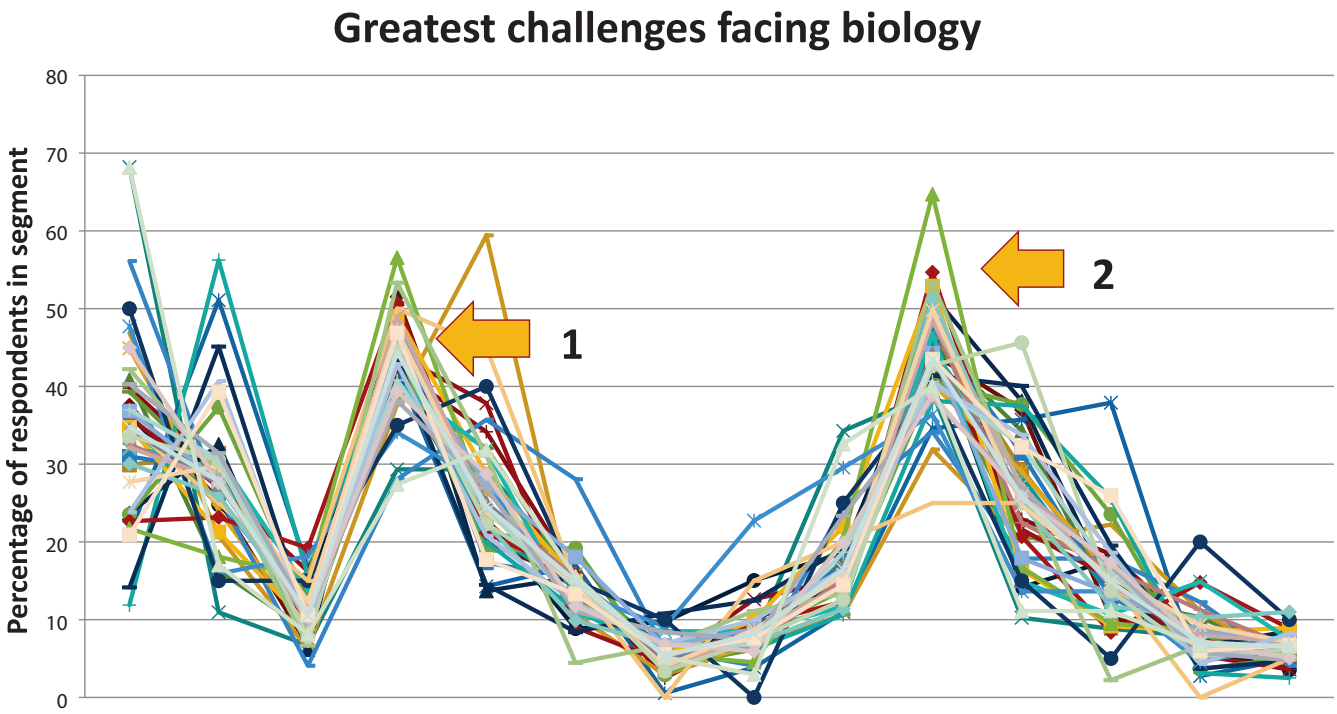

Figure 1. Multisegment analysis of responses to "What are the greatest challenges facing biology?" AIBS survey respondents were examined by 40 different segmenting criteria to observe response variation across their discipline of interest, career stage, and professional setting. Consensus emerged around two challenges: the public's lack of appreciation for biology (marked as 1 in the figure) and decisionmakers' not being informed about issues (marked as 2).

What about those who are not joining professional societies at all?

Our survey instrument was distributed through AIBS's professional contact lists and those of our member organizations. Therefore, our data are biased, because they capture responses only from those individuals probably already involved in the work of a professional society. A deeper investigation into the concerns of professionals who choose not to join societies would allow us to learn how their needs are being met through other means.

Changes affecting all professional associations

In 2011, Mary Byers gave a presentation at the annual meeting of the AIBS Council of Representatives (see Byers's presentation at *www.aibs.org/events/2011_council_meeting.html*). Byers is an expert on association management and a professional consultant on issues of association board development, membership engagement, and program effectiveness. Because many professional associations rely on individual membership–based revenue models, the sociological patterns affecting membership trends in general are also relevant to scientific professional societies. According to Coerver and Byers (2011), membership-based organizations are broadly affected by six shifts that influence how individuals relate to their professional associations: increased competition for their time, an increased desire to see a return on their investment, more organizations competing for their attention, generational differences in the perceived value of membership, increased specialization of interest, and an increased expectation for technological adeptness.

Scientific societies grew from a specialized need

Although one can apply Coerver and Byers's (2011) research about professional association membership in order to understand general changes affecting scientific societies, these latter organizations were formed for a specific purpose and, therefore, require more specialized examination. Ornstein (1913) described the origins of the first scientific academy in Italy, the Academia del Cimento of Florence, as one that represented societies as they were emerging in the seventeenth century:

> Here, nine scientists, supplied with the means of scientific research, have 10 years of united effort to the elaboration of instruments, the acquisition of experimental skill and the determination of fundamental truths: So completely were their efforts welded together that their work was sent into the world like that of a single individual;… their own work and methods [were] the model and inspiration of other learned societies. (p. 89)

At the 2011 AIBS Council of Representatives meeting, science historian Edward J. Hackett, professor in the School of Human Evolution and Social Change at Arizona State University, added to our understanding of the origins and evolution of scientific societies. He said that as the research community produced scientific knowledge, a mechanism was needed for assimilating this knowledge into the public forum. Because governments and institutions of higher education neither could nor would fill this role, professional societies emerged to provide intellectual space for scientists to debate, communicate, and translate their new knowledge to inform society's decisionmaking. Today, scholarly societies continue to play a vital role in connecting science with the public (Potter 2011).

Understanding member-based organizations in the biological sciences

Because there are so many organizations serving those who work in or with the biological sciences, AIBS set out to learn more about the landscape of these organizations in an effort to understand who makes up the biology community and how this community has changed over time.

AIBS began by building a database of organizations in the biological sciences through Web searches. Specifically, we sought to identify scholarly societies and professional associations grounded in or connected to the biological sciences. Although we worked to identify as many organizations as was possible, we recognize that our list is not exhaustive, and we invite the community to add to our always-growing database. By fall 2011, we cataloged 209 organizations (see supplemental appendix A, available online at *http://dx.doi.org/10.1525/bio.2013.63.9.3*) with the following traits: The organization is a membership-based organization, serving individual members, member organizations, or both; the organization is based in the United States, although it may also serve international members; the organization serves a segment of the biological sciences community, although that segment may be interdisciplinary. We chose not to include organizations that served a specific region or state (e.g., the Association of Southeastern Biologists).

We then searched online sources (e.g., organizational Web sites, GuideStar) to catalog the following information about each organization that met our criteria: the name of the organization, the year it was founded, any former names and the years of any name changes, the primary disciplinary focus of the organization, its primary role, its geographic scope of activities, the type of organization, the number of staff and board members, membership or affiliation with meta-organizations (e.g., the American Association for the Advancement of Science, AIBS, the Federation of American Societies for Experimental Biology), the type or types of individual members, historical and current membership data counts, specific areas of members' research interests, and general research interests from a predefined list.

This information was provided to a representative (e.g., the president, executive director, membership

director) of each organization to review, validate, and—where it was possible—fill in any gaps. For a complete description of the verification and vetting process, see supplemental appendix C. Of the 209 organizations identified, 139 validated the data about their organization. We are reporting here on only the organizations whose data we validated through a representative of that organization.

Who is part of the biological sciences community?

Many organizations straddle the line between biology and other disciplines (e.g., the Biophysical Society), so we included an item on the questionnaire that asked the respondents to "Please select the item that BEST describes the disciplinary focus of your organization." The response choices were "biological sciences," "other natural sciences," "general science," "math or engineering," "social sciences," "n/a," and "other." The respondents could select only one response. In asking this question, we wanted to know how each of the respondents saw his or her respective organization's primary scientific identity, if they were forced to choose.

Six representatives indicated that they could not choose just one disciplinary focus for each of their respective organizations for reasons including intentional multidisciplinarity (e.g., the Association for Politics and the Life Sciences) or a wide range of represented disciplines (e.g., the American Pharmaceutical Association).

Although we had expected otherwise, the representatives of the following organizations selected "other natural sciences": the Association for the Sciences of Limnology and Oceanography, the Ecological Society of America, the American Society for Blood and Marrow Transplantation, the Association of Molecular Pathology, the Torrey Botanical Society, the Paleontological Society, the American Bryological and Lichenological Society, the Radiation Research Society, the Soil Science Society of America, the International Society of Quantum Biology and Pharmacology, the American Public Garden Association, the American Water Resources Association, and the International Society of Breast Pathology.

Ultimately, we decided not to use this criterion as a filter to determine which organizations to include in the study. If it were applied, this filter would exclude organizations that are relevant to the biological sciences community; therefore, the final list of organizations on which we chose to report may appear to include some that are on the fringe of the biological sciences.

The organizations included in this study group (n = 139) identified themselves in the manner depicted in table 1.

Which organizations self-identified as scholarly societies?

We asked the respondents to select which type of organization they were representing, using the following definitions: A *scholarly society* is a membership-based organization in existence primarily to advance research in a particular scientific discipline. A *professional association* is a membership-based organization in existence to serve its membership by providing professional development or advocacy work for the profession.

Of the 139 validated responses in the study, 71 respondents identified their society as only a scholarly society (51%), 26 as only a professional association (19%), and 42 as both (30%).

What is the primary role of your organization?

All of the representatives who responded to the question about the role of their organization indicated that their organization had multiple roles. The most frequently identified roles were to provide networking opportunities, to advance research, to publish a journal, and to perform educational services (see table 2).

What is the geographic range of the organization's activities?

Although we focused the survey on organizations based in the United States, almost 89% of the respondents

Table 1. Primary disciplinary focus.

Response	Number of organizations	Percentage
Biological sciences	103	74
Other natural sciences	14	10
General science	5	4
Math or engineering	2	1
Social sciences	4	3
n/a	5	4
Other	6	4

Abbreviation: n/a, not applicable.

Table 2. The primary role of the organization.

Primary role	Number of organizations	Percentage
Networking	125	89.9
Advance research	125	89.9
Journal publication	120	86.3
Education	109	78.4
Student development	77	55.4
Public policy	63	45.3
Serve needs of membership	60	43.2
Public programs	26	18.7
Conservation	26	18.7
Honor society	5	3.6

stated that the scope of their membership and activities was international.

Examining the organizations in size clusters

AIBS asked the representatives to provide information about their organizations' historical membership data, the number of paid staff, and the number of board seats, in order to learn more about how the capacity of an organization changes with its membership size. We plotted membership numbers and identified clusters in the data. Ultimately, we identified eight clusters (see figure 2).

How has the biological sciences community grown and changed over time?

Figure 3 presents the number of newly formed organizations for time periods (mostly decades) from 1800 to 2013. Although the data from 139 organizations were validated by representatives, this chart presents data from 209 organizations, because we were able to obtain information on 70 additional organizations from their respective Web sites or from their Internal Revenue Service Form 990, using GuideStar. (If an organization changed its name, it was counted only once, for the year of its initial founding.)

We found a pattern of dynamic growth in the number of new organizations that serve the biological sciences; however, we also noted that this growth declined during the first decade of the twenty-first century. A closer examination of the names of the organizations established during various time periods (box 1) illustrates the increasing trend toward specialization within the biological sciences.

Changing membership patterns through time

We asked organizations to provide total membership counts and the breakdown of student membership for the years 1960, 1970, 1980, 1990, 2000, and 2010 and examined the ratio of change over the respective decades. The amount of data available for each decade was highly variable. Many organizations were unable to provide historical data, for a variety of reasons (e.g., changes in record-keeping practices or administrative service providers, records in paper format only and not easily accessible). The member counts were compared by creating a ratio of the total number of members at the beginning to the total number of members at end of a decade (e.g., the 2010 total member count ÷ the 2000 member count = the ratio of change over the decade). Figure 4 summarizes the results for the total number of data points available for each decade of comparison (e.g., 69 for 2000–2010, 22 for 1960–1970). Each set of data shows the number of organizations that experienced an increase in the number of individual members that (a) doubled over the lapsed time (i.e., the ratio value was 2.0 or greater); (b) increased with a ratio value of 1.05–1.99; (c) had relatively static growth, with a ratio value of 0.95–1.05; or (d) experienced a decrease in membership size, such that the ratio value was 0.95 or less. Figure 5 displays a similar summary of the data on student membership counts.

The results illustrate that, on the basis of the information submitted, the majority of the organizations increased in size over time. However, despite that overall growth, the results also illustrate that many organizations experienced declines in the size of their membership during the most recent decade (2000–2010). This decline does not appear to have been exacerbated by the economic recession that began in 2008 (table 3).

To understand these patterns, we segmented the data in two ways: First, we segmented by cluster size using the clusters in figure 3; second, we segmented by scientific focus, which was inspired by the analysis of membership trends presented by Blockstein and colleagues (1992).

Organization growth segmented by size

Figure 6 provides a side-by-side comparison of changes for each decade in membership counts segmented by organization size. Although we lack sufficient data to make broad generalizations, the data here indicate that smaller organizations have experienced a much starker downturn in membership in recent years than larger organizations have.

Organization growth segmented by discipline

Figure 7 is a side-by-side comparison of changes in membership counts for each decade, with the organizations grouped by research foci. The data in this comparison indicate that societies related to medical or health research—as well as those that are focused on a suborganismal level of biology—are currently experiencing a period of growth, whereas many of the organismal, ecology, and agricultural scholarly societies are declining in membership. A full list of organizations in their respective discipline groups is included as supplemental appendix B.

Organization growth related to student membership growth

Next, we examined the relationship between the organizations' growth over the period of 2000–2010 and the percentage of their student membership in 2010 (figure 8). The ratio of growth was created by dividing the total number of members in 2010 by the total number of members in 2000. That was plotted against the percentage of students as a proportion of the total membership count in 2010. These data do not tell a compelling story about a relationship between student membership and organizational growth as a strategy for recruiting members.

Cross-generational conversations

In June 2012, AIBS hosted its first cross-generational conversation, bringing together participants from different career stages to discuss issues affecting both the profession and the field (AIBS 2012). Approximately 60 individuals attended, including graduate students; postdoctoral scholars; early-, mid-, and late-career faculty members; members of the AIBS

Figure 2. Size clusters and relevant demographics of the surveyed professional science societies.

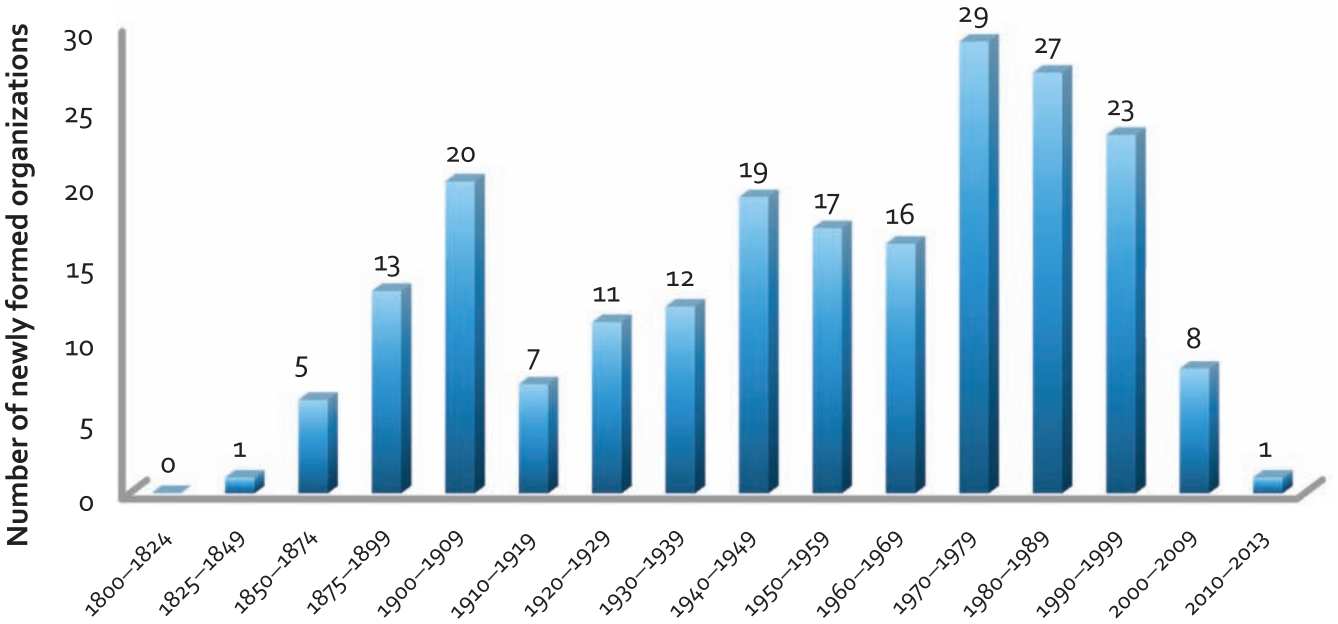

Figure 3. Community growth: The number of newly formed professional science societies over time.

Box 1. A sample of new organizations from the mid-1800s through the present.

Mid-1800s to late 1800s
American Psychiatric Association (1844)
American Medical Association (1847)
New York Academy of Medicine (1847)
American Association for the Advancement of Science (1848)
American Pharmacists Association (1852)
American Dental Association (1859)
Entomological Society of America (1889)
Botanical Society of America (1893)

Early 1900s
Society for Integrative and Comparative Biology (1902)
American Genetic Association (1903)
American Society for Cell Biology (1906)
Soil Science Society of America (1936)
The Wildlife Society (1937)
Society for Investigative Dermatology (1937)
National Association of Biology Teachers (1938)
Society for Developmental Biology (1939)
American Federation for Medical Research (1940)
American Public Garden Association (1940)

Mid-1900s
Crop Science Society of America (1955)
International Society of Biometeorology, USA (1956)
Weed Science Society of America (1956)
Biophysical Society (1957)
Society for the Scientific Study of Sexuality (1957)
National Corn Growers Association (1957)

Late 1900s
Association for Applied Psychophysiology and Biofeedback (1969)
Behavior Genetics Association (1970)
International Society of Quantum Biology and Pharmacology (1970)
Coastal and Estuarine Research Federation (1971)
Society for Leukocyte Biology (1971)
Association for Women in Science (1971)
North American Association of Environmental Education (1971)

Early 2000s
Society for Muscle Biology, Inc. (2003)
Society for Free Radical Biology and Medicine (2004)
The Robert A. Good Immunology Society (2005)
Chinese American Biopharmaceutical Society (2006)
International Society for Zinc Biology (2008)
Society for the Advancement of Biology Education Research (2010)

Board of Directors; and AIBS staff members. The event provided a space for attendees to discuss their relationships with scholarly societies and other topics of professional interest. During the meeting, two questions arose that are worth further structured investigation:

Why do some early-career professionals not join a professional society? A small number of attendees at the event had never joined a scholarly organization. When

Figure 4. Change in membership: The number of organizations whose membership increased for each decade as a ratio of the change. The n *associated with each line is the total number of data points available for that decade of comparison.*

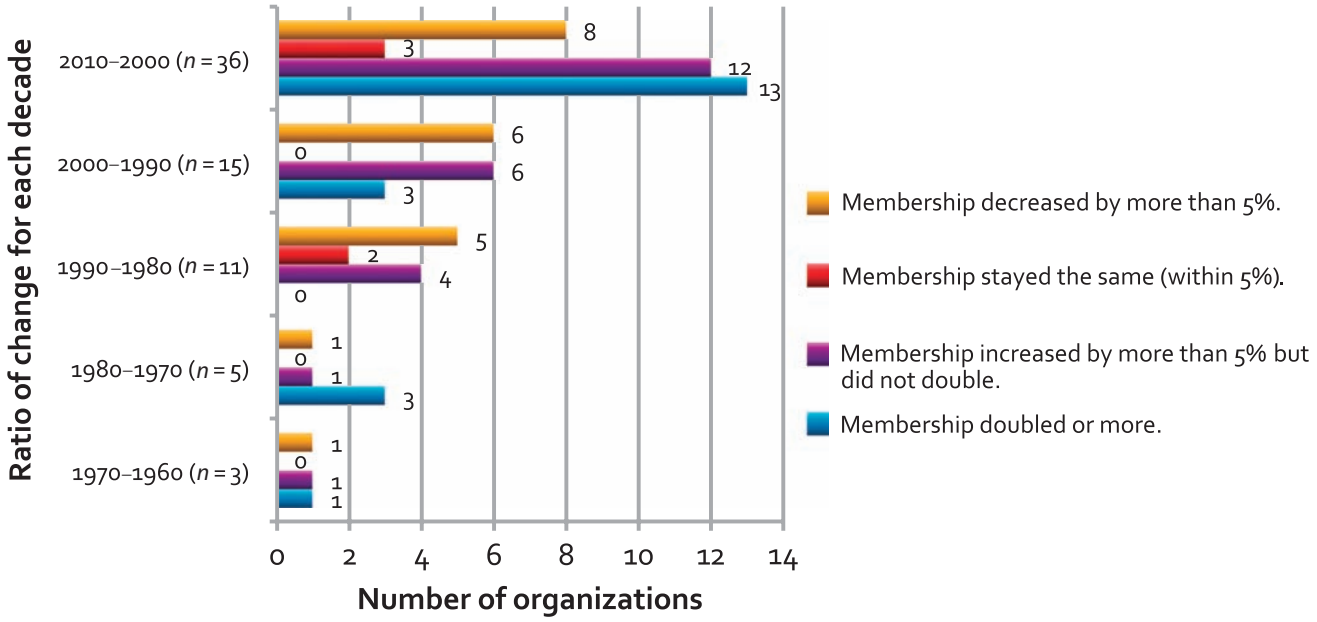

Figure 5. Change in student membership: The number of organizations whose student membership increased for each decade as a ratio of the change. The n *associated with each line is the total number of data points available for that decade of comparison.*

Table 3. Membership counts for 2000–2005 and 2005–2010.

	2000–2005 (*n* = 64)		2005–2010 (*n* = 81)	
	Number	Percentage	Number	Percentage
Organizations whose total membership count grew more than 5%	25	39	36	44
Organizations whose total membership count decreased by more than 5%	27	42	29	36
Organizations whose total membership count varied less than 5%	12	19	16	20

they were asked why, they generally expressed that they had not yet encountered a reason to do so or that they had found mechanisms for accessing the benefits without being compelled to join as members (although most anticipated that they would likely join a society at some point in their professional experience). We would like to further explore this demographic

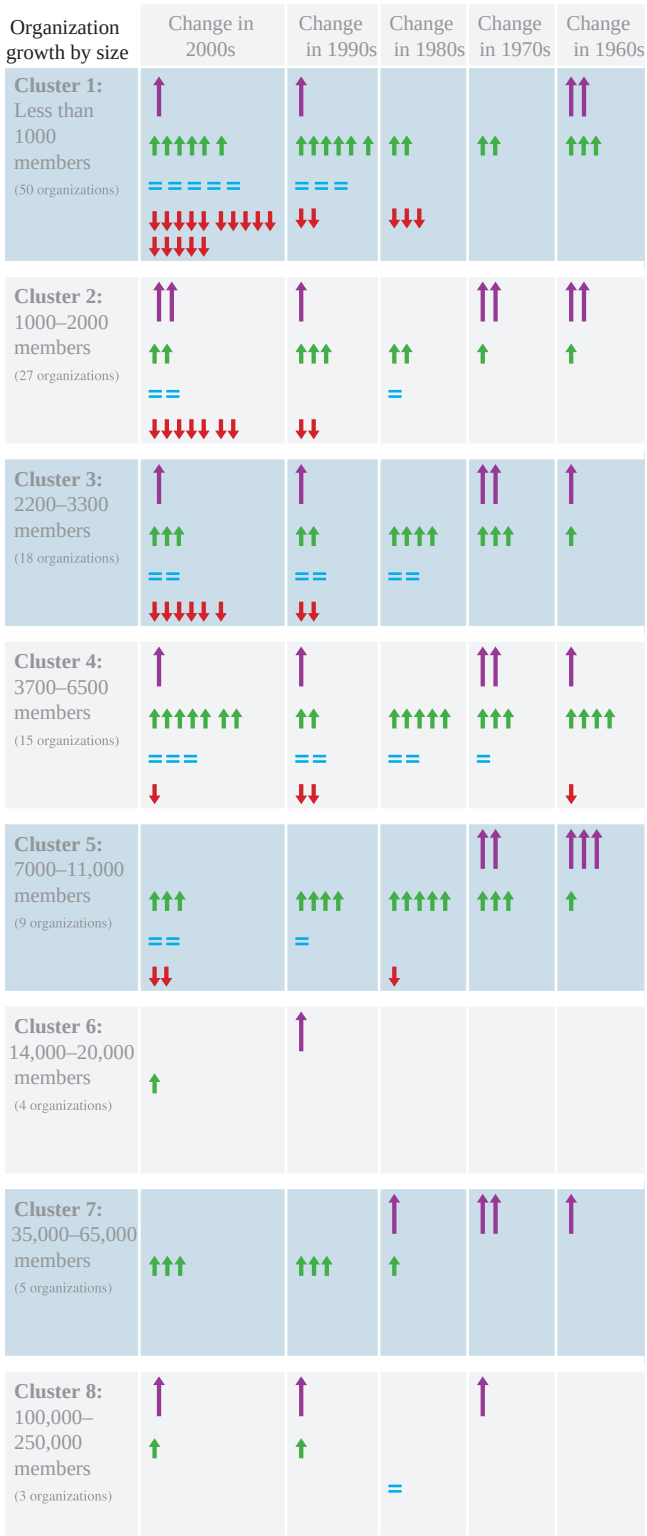

Figure 6. Organization growth per decade arranged by size. The purple arrows represent a rate of change of 2.0 or more, the green arrows represent a rate of change of 1.05–1.99, the equals sign represents a rate of change between 0.95 and 1.05, and the red arrows represent a rate of change less than 0.95.

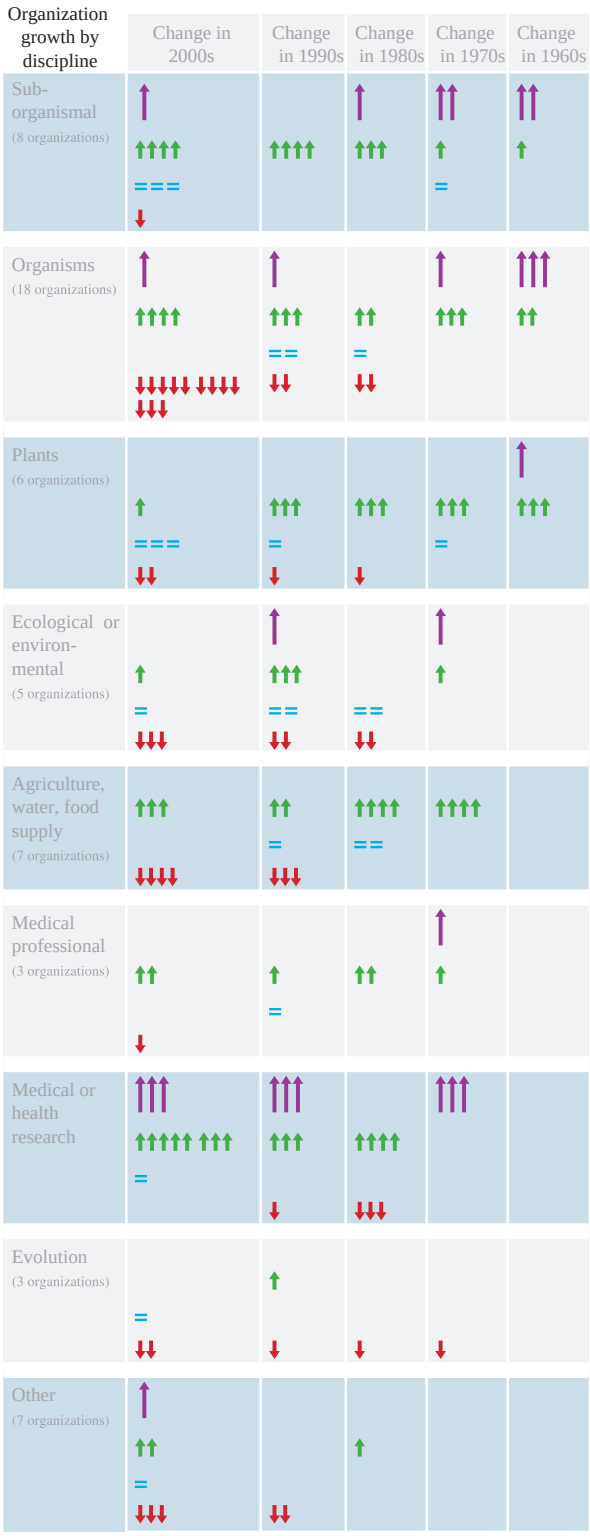

Figure 7. Membership changes per decade arranged by scientific discipline. The purple arrows represent a rate of change of 2.0 or more, the green arrows represent a rate of change of 1.05–1.99, the equals sign represents a rate of change between 0.95 and 1.05, and the red arrows represent a rate of change less than 0.95.

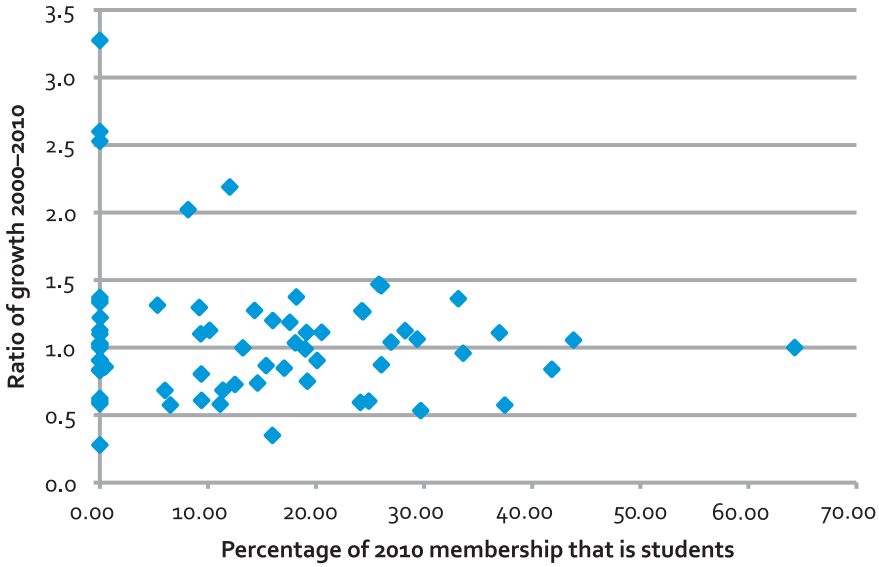

Figure 8. The ratio of the change in professional science society membership between 2000 and 2010 as a function of the percentage of memberships that were students.

to help inform the development of value propositions that societies offer to prospective members.

What inspires biologists to join a professional society? An interesting point was raised during the conversation regarding a potential change in how we communicate the benefits of and reasons for scholarly society membership. Anecdotally, there seemed to be a cultural shift in how this communication takes place and whether it even does so. We would like to further explore the topic of how successful we are as a community at sharing the important function of scholarly or professional organizations in the biological sciences.

The next chapter

The community as a whole looks to scholarly professional societies in the biological sciences as a communication network for advancing biology. The results of AIBS's research can help inform conversations about the role of professional societies, given what we learned about the varied landscape of biological organizations' capacities, resources, and roles. Likewise, as professional societies explore new ways to support the needs of their ever-evolving communities, they can use these insights to respond and adapt to their diverse portfolios of members.

Over the next year, AIBS will be taking a closer look at organizations that are embracing change in novel ways and using new opportunities to bolster their efforts. By sharing these bright spots, we can illustrate how the community as a whole can fulfill its role to advance science, serve its professional members, and communicate its scientific knowledge to the public. Dynamism is the new stasis, by which we mean that there will be many opportunities for bolder and more innovative approaches in the more than 200 professional societies and associations that serve the community of biological scientists.

In addition, organizations and individuals that constitute the biological sciences community should explore how and when to act in a coordinated way to address our greatest challenges: advancing the public's appreciation of science, ensuring that decisionmakers are informed about the value of basic biological research, and addressing the unforeseen hurdles and opportunities that lie ahead. It is clear that there is a considerable need for coordinated action around these issues, while, at the same time, individual professional societies strive to respond to the scientific and professional needs of the twenty-first century biologist.

As we continue down the path to better understanding the dynamics of our professional system and our capacity to address our common and individual concerns, AIBS will continue to share what we learn. We are grateful to the 139 organizations that helped us bring this new information to the community.

Our next phase is to explore the following critical questions: *In order for the life sciences to thrive, what opportunities are too great to miss? What transformations in practice and infrastructure need to take place to prepare biology to meet the twenty-first century needs of society? What challenges must be overcome to ensure our success?*

The AIBS Council meeting in December of this year will explore these issues in more depth, consider the responses to these questions offered by leaders in the field, and discuss how we, as a community, can best respond.

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