

Response to Recommendations from the Committee of Visitors
Division of Integrative Organismal Systems
June 17 – June 19, 2014

INTRODUCTION

The Directorate for Biological Sciences (BIO) would like to thank the Committee of Visitors (CoV) for their efforts in evaluating the management and outcomes of the Division of Integrative Organismal Systems (IOS) at NSF. BIO is aware of the extraordinary amount of work that the CoV members contributed before and during the meeting and is especially appreciative of their commitment to this important review. The thoughtful report that emerged from the CoV deliberations is highly appreciated by BIO and IOS. BIO appreciates the thoughtful responses to the questions posed to the CoV in Part C of this report.

RECOMMENDATIONS AND RESPONSES

Section I: Questions about the quality and effectiveness of the program's use of merit review process.

Recommendation: ...We commend IOS personnel for the thoroughness of its reviews, for overseeing complete and useful panel summaries, and for conducting analyses that justify funding decisions. A clear strength of the review system consists of providing a complete review for all proposals, without recourse to a triage system. We also commend IOS leadership for the thorough analysis of the transition to the pre-proposal system that justifies its benefits.

Response: IOS has worked diligently to ensure that high standards of merit review are upheld, even in the face of mounting proposal pressure and limited funding resources. We appreciate the commendation from the COV and will continue making data driven decisions.

Recommendation: ...However, given that we still found a few delinquent ad hoc reviewers and even a few proposals with inadequate broader impacts, NSF should continue educating its stakeholders about the value of broader impacts and on how to evaluate them. We recommend continuing to give guidelines (length and content, as well as potential elements in a good broader impacts section) to both PIs and reviewers.

Response: IOS actively encourages principal investigators and reviewers to seriously consider the broader impacts criteria. We consistently highlight the importance of Broader Impacts in our outreach presentations, panelist briefings, reviewer instructions, and individual correspondence. BIO offers guidance on its home page about broader impacts as well. We will continue these practices and will also consider revising the language in our solicitations to highlight the importance of the Broader Impacts section for both applicants and reviewers and posting a feature on the IOS Blog regarding broader impacts.

Recommendation: In the vast majority of cases, panel summaries provide clear rationale for panel consensus or lack thereof. In cases where the individual reviews are much more positive (or negative) than the panel placement, it is important that the panel summaries address this apparent disconnect. In the case of pre-proposals, the COV suggests that panel summaries provide substantive advice for improvement to investigators whenever possible.

Response: Panel summaries are accounts of the panel discussion developed and drafted by the reviewers and we do not wish to dictate the content. However, IOS staff will work to encourage clear messages from the panel to the applicants during panel orientation and throughout the proposal discussions. We will include suggestions during our pre-panel briefings about highlighting how disparities in individual reviews were resolved during the panel discussion in the panel summary. While panels do not need to come to consensus, the nature and basis of split recommendations should be clearly communicated to the PI. IOS staff routinely reviews the panel summaries during the panel and can also make suggestions to improve clarity while the draft is in progress.

Recommendation: We recommend that, whenever there is a discrepancy between the award/decline decision, panel recommendation, panel summary, and/or individual reviews, this discrepancy be explicitly addressed in the review analysis. The COV suggests that IOS consider streamlining the review analysis process to focus efforts on those proposals for which discrepancies take place anywhere in the process.

Response: Per NSF policy, our review analysis procedures already highlight any reviews that are inconsistent with the ultimate recommendation. For Invite/Award decisions, any Fair or Poor reviews must be described. For any Not-Invite/Decline decisions, any Excellent reviews must be described. But, we will work on providing additional detail where it can be informative or useful. In some previous cycles, we considered streamlining the review analysis as the COV suggests, primarily through the use of “boilerplate” review analysis. Although, in many cases the boilerplate text was sufficient documentation that the process was followed, it did not provide the nuanced analysis needed for program management and constructive interactions during PI phone consultations. In our experience, the boilerplate text did not sufficiently document more complex decisions. In addition, the review analyses are the primary documentation of the decision consulted during a request for reconsideration. Hence we feel that the Program’s rationale needs to be more fully articulated than boilerplate analyses will allow.

Recommendation: While awardees likely do not seek further input, rationales for negative decisions (especially when some or all reviews were positive) could be strengthened. PO advice to panelists that write summaries is a key point for enhancement in this regard. It could also be that such guidance to the PIs is provided by POs but not recorded in the jackets. Documentation of any more informal discussion would strengthen the jackets and improve the effectiveness and transparency of proposal review, although we hesitate to increase program officer workload.

Response: Currently the best practice is for Program Directors (Note: that throughout this document we will use Program Director for consistency rather than Program Officer) to include additional guidance to PIs in the “PO comments” section of the jackets which is available to the PI in Fastlane. Many of the PIs, both potential awardees and those whose proposals have been declined, call their Program Director for extended discussions that are indeed difficult to document in eJacket Per NSF policy, Program Directors should include Diary Notes of telephone conversations and other significant input received in the jacket. However, providing notes or transcripts of every call for storage in the eJacket system would indeed be rather cumbersome and many calls to program directors occur prior to submission when there is no jacket associated with the information. IOS will work on a “best practices” approach to encourage appropriate use of Diary Notes and PO Comments.

Recommendation: The COV encourages IOS to continue the practice of occasionally using ad hoc reviews for pre-proposals, especially in cases where appropriate expertise is not available on the panel. The COV commends the inclusion of broader impacts as a review criterion, and encourages IOS to continue to emphasize and enhance this.

Response: We appreciate your recognition of the special attention paid where necessary for some proposals, and will certainly continue this practice. The inclusion of broader impacts as a review criterion is explicit in the NSF Merit Review standards, and has been fully endorsed by the IOS Division.

Section II: **Questions concerning the selection of reviewers**

Recommendation: It is important that reviewers of pre-proposals be encouraged to concentrate on the importance of the questions and adequacy of the experimental designs to answer them, and less on the use of specific methods or taxa, or evidence of preliminary data. It is important that Division staff continue to identify when these disconnects occur and correct them with additional review, and continue to downgrade any reviews that clearly do not show an understanding of the importance and broader context of a proposal.

The collaborative nature of science, along with the new method of identifying conflicts of interest (e.g. pre-proposal submission causing conflict for all panels within the cluster for the entire year) has greatly reduced the number of potential panel reviewers. The COV strongly recommends that NSF reconsider the broad conflict of interest policy because of these unintended consequences.

Response: We will continue to carefully evaluate the content and quality of all reviews. The conflicts rules are decided in the Office of Policy, so IOS cannot unilaterally change the COI process. But, we are actively seeking alternative means to resolve the conflicts management situation. The next COV will be provided with updates about our progress in managing the COI issues.

Recommendation: Another case of COI is when a PI feels that a particular reviewer will provide a review that is biased by some prior interaction or competition with the PI. It is imperative that these designations, given there is not an unreasonable number of them, continue to be respected. Also, it is important for Division staff to continue to identify reviews that represent outliers and assess whether those reviews may be biased and represent a COI.

Response: The COV rightly points out that there are many factors involved in reviewer selection and evaluation of reviews. Current COI designations follow NSF wide policy which includes respecting PI requests regarding conflicts of interest and IOS continue to do so. Per NSF policy, Program Directors are required to address outliers and empowered to evaluate potential bias and potential COIs and request additional reviews when necessary. IOS will continue to follow these NSF wide policies.

Section III: Questions concerning the management of the program under review.

Recommendation: The COV recommends that IOS carefully consider the ideal mix of permanent officers and rotators.

Response: IOS maintains ongoing discussion of staffing needs within the Division and across the Directorate. The balance of permanent and rotating science staff is a chief topic in these meetings. The recommendation from previous discussions has been to maintain staffing such that 50% of the program directors are permanent and 50% rotating. IOS is almost at this point. The goal is to maintain a balance between continuity of operational knowledge and fresh community perspective on scientific opportunities. There are some constraints on the availability and timing of hiring, but in both the short and long term we will be working to balance and optimize our staffing to support new and continuing scientific directions and handle the increasing proposal pressures.

Recommendation: The COV recommends having some overlap between incoming and outgoing rotators to assist in training/continuity, and recommends that IOS encourages multi-year terms for rotators.

Response: To the extent that we can do so within the staffing rules and regulations, overlap of incoming and outgoing rotators is a highly desirable plan. We are investigating our options to allow exactly the sort of knowledge transfer and continuity suggested by the COV. In addition, all of the rotators work closely with the permanent staff in each cluster upon arrival, during their time at NSF, and as they transition out to ensure continuity of process and program management. We will also emphasize the utilization of structured training activities, especially for incoming rotators so that they develop full proficiency as quickly as possible.

Recommendation: The COV is concerned about the heavy workload on each of the program officers and recommends that the vacancies in permanent program officers be filled as quickly as possible. In addition, a review of the structure of IOS may allow IOS

to find efficiencies in management that help balance the review process with programmatic responsibilities.

Response: As noted above, IOS is actively recruiting new permanent staff, rotators, and engaging the Office of the Assistant Director in staffing needs discussions. We absolutely concur with the COV about the need to fully staff the Division to allow for timely and efficient processing of proposals and awards management.

Recommendation: IOS has used an external process such as Know Innovation Ideas Lab to engage scientists and fund a few emerging collaborative proposals to further develop emerging research areas. The program officers also take advantage of EAGER and RAPID projects to fund emerging ideas. These ad hoc approaches give the POs the flexibility to fund areas that they think have potential for the future but it does not negate the need for IOS to develop a strategy to identify and respond to emerging issues in a more cohesive way.

Response: We have been actively involved in supporting PI meetings, public discussions (e.g., the BIO G2P Wiki), communicating through our “blog” and using similar community outreach efforts to help identify emerging issues. In the near future, the BRAIN emphasis area and the Genomes to Phenomes (G2P) grand challenge will likely form the main component of our special activities outside of core programs. Our continued use of new data analytics tools will also allow us to track program foci over time and help identify emergent areas.

Recommendation: From review of the electronic jackets, there were occasions when proposals in medium priority were funded over high priority proposals to meet the needs of the portfolio and, therefore, the criteria for making these decisions is critical. Moreover, there is no discussion about how IOS develops a strategic vision across the division with respect to portfolio priorities. The criteria for making funding decisions within the context of the research portfolios is fundamental to the mission success of IOS, and deserves a thoughtful process for achieving that goal.

The COV recommends that IOS Program Officers describe the criteria and processes used to develop portfolio priorities that meet the goals of the clusters and of the IOS division.

Response: The current debriefing template employed by IOS emphasizes documentation of rationale on a proposal-by-proposal basis. The contents of a program’s group of active awards, the portfolio, are dynamic as each year new projects are added and previously funded projects end. In this dynamic context, POs consider a variety of dimensions when making decisions with the goal of producing a diversified and balanced portfolio. The primary focus is on the potential impact of the science proposed, the balance among sub-fields, and the potential for the research to inform other areas of Biology. POs also balance the portfolio along other dimensions including geography, EPSCoR status, institution size and type, amount of risk, career stage of the PIs, broadening participation goals, and prior funding all of which are weighted relative to the contents of the program’s portfolio. Documentation of the rationale for each

decision relative to the portfolio is typically included in the rationale section of the review analysis. The Division leadership will solicit input from the Program Directors about how to best document and disseminate the overall portfolio rationale and implement feasible suggestions so that the next COV will have greater clarity on our process and rationale.

Recommendation: The 2011 COV also expressed concern that many highly meritorious awards continued to be declined. Our COV shares this concern. Without increased funding levels this will continue to be a debilitating problem.

Response: We concur with the COV concerns about our overall funding levels.

Section IV: Questions about Portfolio.

Recommendation: To help support the community that is funded by IOS, the COV recommends considering reducing the size of awards to fund more of them. One approach might be to include an additional small awards program.

Response: We appreciate the level of concern offered by the COV in relation to award size versus the number of awards. All of the NSF Program Directors constantly evaluate each award recommendation to make an appropriate award that includes only necessary and allowable costs and yet has sufficient support to actually achieve the stated experimental objectives. As panels (and even this COV) recommend more integrative, collaborative, and multidimensional projects with ever-increasing sophistication, there is a natural tension between having enough support to do the science that will advance a field and supporting the large corpus of researchers who would want to contribute to such advances. We will conduct an extensive analysis of the current percentage of small awards in IOS and their distribution by program, noting that a special program is not needed to allow POs to make small awards. Indeed, introducing such a program could have an undesirable effect on the scope of science proposed and have negative impacts on the health of IOS science in the long term. Smaller budgets may be requested now. Except for CAREER awards, there is no lower limit on budget size. As noted elsewhere in the COV report, the primary problem is not excessive award size. We simply do not have adequate funds to support all the strong research projects that PIs would like to pursue. We concur that the major obstacle for IOS in achieving its goals is funding constraints.

Recommendation: The number of highlights declined significantly over the three year period; there were 30 in 2011, 23 in 2012, and 8 in 2013. The reason for this is not known, but the COV wonders if the high workload for Program Officers might contribute to this decline.

Response: There is no obvious reason for the decline in Highlight submissions, and we will work to more closely track this activity to understand where the impediments lie.

Recommendation: The NSF Strategic Plan states that potentially transformative research is a major focus, and that NSF will "emphasize interdisciplinary and system

oriented approaches that often lead to transformative concepts." It is not clear how this is being done.

Response: During panel discussions, consensus agreement is reached as to whether a proposal should be designated as having transformative potential. All panelists are provided with the official NSF definition of transformative potential (https://www.nsf.gov/about/transformative_research/faq.jsp#Q1), and briefed on the topic before the panel discussion starts. Such designations are recorded in the eJacket system. Likewise, there are some programs where interdisciplinary research is a priority area (e.g., the BIOMaPS program), and special coding is added to each award supported by such funds for tracking purposes. As these designations have not been in operation for very long we will be doing our first analysis of their predictive value during the next COV period.

Recommendation: It was recommended in the previous COV report that all multidisciplinary designations should be validated at the time of the award, but it is not clear if this is being done. COV recommends that panel members might be asked to confirm this.

Response: IOS will consider modification to the panel summary template to facilitate panel commentary and deliberation on this issue.

Recommendation: The COV recommends that the IOS continue efforts to increase the participation of 2-4 year institutions in the IOS portfolio.

Response: We concur with the COV that increased participation by 2-4 yr (primarily undergraduate) institutions is a priority. We have already initiated several outreach visits. Also, as noted in the materials provided to the COV, one of our rotators (Dr. R. Slocum) published the results of his analysis of PUI participation and success rates at NSF in the Council for Undergraduate Research Quarterly (http://www.cur.org/assets/1/23/Fall2013_v34.1_slocum.scholl.pdf). The PUI analysis has been highlighted as promising evidence for PUI's that they really can be fully competitive, if they submit proposals. We also intend to highlight such messages on our IOS blog for greater community awareness.

Recommendation: COV recommends that IOS provide sustained support for RUIs, which is essential to keep a balanced portfolio. Future support of educational activities would be facilitated by reinstating DDIGs, which currently are only offered by Animal Behavior. COV recommends expanding DDIGs for the entire division in order to both directly support existing research programs as well as to integrate research with education for the next generation of PIs.

Response: Proportional and balanced support for RUI proposals is clearly an appropriate goal and IOS fully concurs with the COV recommendation. RUI proposals are tracked during proposal management, and are specifically featured in our debriefing materials after each round of competition to ensure that appropriate support is provided.

IOS is in the midst of an analysis of the costs and benefits of the DDIG program. Costs for the awards supported by program are relatively low, but do come from the same budget pool that supports regular awards from the core programs. So, there is a counter-pressure on success-rates between the programs. Furthermore, the time and effort required to manage the DDIG program is quite substantial. As the COV has highlighted, our labor resources are already stretched thin, so it is not clear how we would manage a large increase in proposal numbers if DDIGs were spread throughout IOS. We recognize the important aspects of professional development afforded to graduate students by the DDIG program and are researching whether alternative approaches could be developed to meet such needs.

Recommendation: The COV commends IOS for diversity broadening activities that have attempted to cultivate under-represented group involvement in IOS, such as reaching out to larger membership societies. According to leadership presentations and the IOS self-study, this has had limited success. The COV recommends increased efforts to reach out to minority institutions and regional societies with higher minority memberships, as well as inner city schools and rural areas without regional influence of colleges and universities.

Response: We appreciate the recognition of our broadening participation (BP) efforts. The coordinated approach through professional societies is relatively new, thus with limited demonstration of results so far. But, we are hopeful that the effort will continue to develop and progress. We have also formed an IOS BP working group, and the BIO Directorate has just recently (August 2014) formed a BP working group to coordinate efforts across Divisions, share best practices and successful approaches, and increase our BP efforts overall. We expect to offer frequent updates on such activities through our outreach presentations and public communiqués.

Recommendation: The implementation of the Career-Life Balance (CLB) Initiative in 2012 (www.nsf.gov/pubs/2012/nsf12065/12065.jsp), which was incorporated into CAREER supplements in 2013, is an important step towards retaining women in the academic ranks. It is not evident whether these initiatives have been supported by IOS, and whether their implementation has been even across clusters. It may be necessary to educate POs in this program. The COV urges IOS to take the lead at NSF and re-instate a mechanism for support of parental leave (men and women) for child and/or elder care for both postdocs and PIs at all stages of career.

Response: We have made a number of CLB supplements and will continue to support them. IOS will work to make the POs and scientific community more aware of their availability through our outreach presentations and public communiqués.

Recommendation: What are the other mechanisms that IOS, BIO and NSF as a whole can use to disseminate the knowledge obtained by the funded research to inform and inspire the public, and especially our nation's students? We note the popularity of Science Cafes, FaceBook, YouTube, Twitter, and other social media and suggest that

they could be inexpensive and effective approaches to recruit and foster the next generation of scientists and communicate science to the public.

Response: Most of the STEM dissemination supported by IOS is actually performed by the PIs on IOS awards. We strongly emphasize broader impacts during the review process for exactly this purpose. In addition, IOS has started and will continue to develop our blog site to provide additional outreach more directly. We have also provided support for a number of “NBCLearn” film projects. Our efforts in this area are primarily limited by our staffing which as the COV has noted are currently fully taxed.

Recommendation: We envision IOS as a world leader exemplifying an agency in support of integrative biological systems. Toward this goal, IOS could clarify its mission with quantitative metrics that could be evaluated yearly to assess the quality and balance of the portfolio. Presently, the significance and impact of the funded projects is difficult to discern. In the future, it would be very helpful for IOS to provide a list of publications and bulleted summaries of the most significant achievements of each cluster during the review period (not merely providing a list of Highlights titles). As previous COVs have also stated, it is imperative that IOS quantitatively measure the impact of its programs retrospectively. Infrastructural support in the form of adequate staff, meeting space, and implementation of computational resources appear to severely limit portfolio management as well as logistics. The COV strongly applauds IOS's development of a new database management platform to begin to mine IOS data.

Response: We concur with the COV that infrastructure, logistic, and staffing support have limited our ability to perform exhaustive impacts analysis noting that often impacts are not fully realized until some years after the end of a project. However, we have already initiated development projects to address these constraints. The entire Foundation struggles with the issue of impacts assessment, and the IOS activities are part of a larger and developing framework for transparency and accountability. Recent improvements in the annual reports system, Research.gov, and related computer systems should greatly facilitate our analysis efforts. We look forward to sharing the results of our work in this area with the next COV, and with the community at large as results are generated.

PART B. RESULTS OF NSF INVESTMENTS

B.1. OUTCOME GOAL for DISCOVERY:

Recommendation: Based on the current set of awards, future IOS award selection is expected to be consistent if award funding levels keep pace with annual inflation. However, a list of manuscripts, patents, and products that can be directly connected to IOS funding may be more effective to evince productive outcomes of IOS support, and is correlative with the need for a more data-driven assessment of funding impact.

Response: As noted previously, IOS is aggressively developing tools and data analysis capacity to improve portfolio analysis, including the impacts assessment recommended

by the COV. We expect to provide more detailed information about project impacts and productivity in the coming years.

B.2 OUTCOME GOAL for LEARNING:

Recommendation: The COV commends IOS for its significant efforts. However, an expansion of the DDIG program is recommended in order to foster Ph.D. student skills in synthesis, critical thinking, development of independent research ideas, experimental design, and written communication. In addition, scientific literacy for all citizens can be expanded by investing more in primary and secondary science education, especially in science desert areas observed in inner city schools and rural areas.

Response: IOS is very mindful of the fact that the DDIG program can be a great learning experience for some students. But, we are ultimately not tasked with directly providing graduate education experiences. Such activities are much more properly conducted through College and University frameworks. Toward that end, we provide extensive support for graduate students on a number of awards to individual PIs or collaborative teams. It should also be noted that the NSF EHR Division of Graduate Education also offers a number of graduate support programs, e.g., the NRT (<http://www.nsf.gov/pubs/2014/nsf14548/nsf14548.htm>). IOS also supports STEM outreach and engagement through the broader impacts costs associated with our awards.

B.3 OUTCOME GOAL for RESEARCH INFRASTRUCTURE:

Recommendation: However, the self-study and supporting materials did not include sufficient examples of specific experimental tools, approaches, and contributions to the national infrastructure stimulated by IOS initiatives. The COV did not find the Highlights provided particularly compelling to make the important point that IOS initiatives enhance multiple dimensions of the nation's research infrastructure.

Response: As noted above, we will work to improve the COV offerings that document IOS-stimulated initiatives and impacts.

Recommendation: However, the COV recommends better dissemination of best practices and education for investigators regarding how to develop appropriate DMPs for their specific data. Given the recency of the DMP requirement the COV was unable to evaluate how well PIs are implementing DMPs.

Response: We agree that dissemination of best-practices for DMPs is a good idea. The BIO directorate currently provides guidance regarding DMPs on the BIO home page (<http://www.nsf.gov/bio/pubs/BIODMP061511.pdf>). IOS has been actively involved in a BIO- and NSF-wide analysis of DMP contents, practices, and scope in collaboration with staff from BIO OAD. We hope to publish and publicize these findings when complete to better educate investigators about options and expectations. There will also

be additional guidance in the near future when the official NSF Public Access plan in response to the Office of Science and Technology Policy's memo regarding access to federally funded scientific research (http://www.whitehouse.gov/sites/default/files/microsites/ostp/ostp_public_access_memo_2013.pdf) is approved and posted on the NSF web site.

B.4. OUTCOME GOAL FOR ORGANIZATIONAL EXCELLENCE:

Recommendation: The collaboration between the program analyst and cluster/program officers is both commendable and exemplary. We encourage IOS to not only continue this collaboration, but to expand it to include assessment of outcomes of initiatives and funded projects. IOS and NSF are at an exceptionally good moment to use data to evaluate the success of initiatives, aspects of these initiatives that must be changed, and to identify initiatives that are deemed particularly successful and importantly, unsuccessful. From previous COV reports, it appears that this is an area that the community has demanded. Assessment of achievement of mission goals is a fundamental good business practice.

Response: As noted previously, we fully concur with the COV recommendations in this area. It is only recently that we have begun to have the tools needed to be able to achieve this goal. We have worked on both staff recruitment and staff training to improve our data analysis options, and plan to continue this practice into the future. Developing the means and methods for impacts assessment is a high priority for IOS. NSF as a whole is also working on better analysis of impacts and outcomes as part of Transparency and Accountability activities.

Recommendation: ...we hope that this shuffling in leadership is a temporary problem, and we recommend longer term stability in IOS leadership.

Response: The Division is now in the process of recruiting the permanent and rotating members of the Division leadership team as well as additional permanent Program Directors. We expect renewed stability in coming years.

Second, COV members would have liked to see justification of how the Division's organization and structure best satisfies its mission and goals. The COV recommends consideration of the subdivision of clusters into multiple programs, the balance between program officers/directors and program specialists, analysts, and assistants, and the hiring and length of stay of rotators.

Response: Additional organizational information will be included in future COV documents to better address this recommendation. Divisional organization is being evaluated at the present time. The next COV will be provided with detailed rationale for any changed or persistent organizational decisions.

C. OTHER TOPICS

Recommendation: Core components are working well so far; even as we make suggestions for fine-tuning, we urge the Division not detract from the many elements that are fully functional and forward-thinking.

Response: We appreciate the vote of confidence and the recognition of successful outcomes. We share the optimistic COV view of the need and opportunity to fine-tune an already robust process.

C.1. Recommendation: ...we did not receive as much information regarding the nature of inter-program activities or inter-divisional funding and solicitation; these obviously exist, but might be better emphasized in any subsequent self-study so that we see clearly how they provide new directions. We also expected to see more co-funding, especially in such areas as computational neuroscience, but this might be an omission in text, not in action.

Response: This is a good suggestion and an area where we have a lot of activities that could be better emphasized. The next COV will be provided with additional detail about co-funding and special activities.

C.1. Recommendation: A second concern is that the several specific subprograms should emphasize their integrative nature, because we fear that when the science is broken into specialized areas, integrative work may not be facilitated. At the same time, we note that solicitations for targeted research in integrative, cross-program areas would help to advance the science. We were not able to assess the extent of cross cluster, cross division, and cross directorate efforts. We encourage such integrative interactions to avoid the potential problem of apparently facilitating overly specific research efforts that operate in isolation.

Response: This is another good suggestion and an area where we have a lot of activities that could be better emphasized. The next COV will be provided with additional detail about co-funding and special activities.

C.2. Recommendation: We have a few suggestions: 1) we urge IOS to continue awards to mid-career people for re-training; 2) we recommend resurrecting the career-life balance supplement awards. Few members of the community seem to be aware of them, and IOS should take the lead at NSF in encouraging these important awards; 3) we suggest that IOS enhance international collaborations more actively (some exist, both for NSF personnel regarding program development and for individual investigators). We commend IOS on interacting with other divisions and directorates in funding international programs, for example sometimes incorporating USAID funding for partner nations and in the BREAD program. This is the out-of-the-box thinking that will maximize support and research interactions.

Response: The COV emphasis on enabling programs that promote career-life balance and retention in STEM disciplines is most welcome. We plan to continue our support for

mid-career award and career-life balance supplements, and will include information in future outreach activities, public presentations, and the IOS blog.

C.3. Recommendation: We see three general areas that we urge NSF to address that might strengthen the program's efforts. One has to do with proposal review: as research is becoming more collaborative, the broad conflict-of-interest interpretation (e. g., eliminating collaborators within 48 months) may exclude many potential reviewers and much expertise. Pre-proposal requirements have exacerbated the difficulty. The second is that it would be desirable to continue to develop research and discussion/policy interactions with other Federal agencies, NGOs, and, in some instances, professional societies. Some ongoing and new programs exist and illustrate good value, but more are needed. Third, it would strengthen programmatic efforts if data regarding publications, patents, and new techniques are gathered from annual/final reports using new data management tools. These outcomes should be made available publically to illustrate more widely the results and impacts of NSF support for research.

Response: The COI policies are not set by IOS, but we will share the COV concerns with the BIO OAD and NSF Policy office. IOS is committed to active management to maintain the integrity of the merit review process. IOS has already started discussions and planning along these lines and will provide updates to the next COV, and through public forums when appropriate. We are likewise involved in discussions about partnership activities and expect to offer additional detail as soon as the activities are formally approved and announced. Finally, we concur with the need for improved analysis and reporting of project outcomes and impacts. As noted elsewhere in this response, the whole Foundation struggles with this issue to some extent. IOS is actively involved in tools development and data analysis to improve responsiveness to this COV suggestion.

C.5. Recommendation: We request that the preparers of the divisional self study try to assure that the data, examples, and other materials fit the review template, especially in the area of NSF goals. Parts of the draft fit well; other areas were not really filled out but rather referred to Highlights and various documents. It would have been useful to have the information in the documents summarized to provide the interpretation or to substantiate a goal. Also, it would be more informative to provide examples of accomplishments, in addition to examples of processes.

Response: We apologize for any logistical challenges posed by our data presentation decisions. We will take the COV suggestion to provide more synthesis and analysis of the data in the self-study for the next COV.

C.5. Recommendation: Discussion time with IOS program officers during our visit was very useful; perhaps separate times for separate clusters, rotators and permanent people, POs from other Divisions, might be provided. Access to the eJacket module proved cumbersome for several COV members (e. g., too many COV members had password and other problems; some files couldn't be opened, etc.). We also had some issues with data comparability, of which IOS is well aware from its own perspective.

Response: We are glad that you found the discussion with Program Directors useful. We would be glad to work with the next COV to arrange an agenda that includes more such discussion opportunities. We sincerely regret any technical issues that were not resolved in a timely fashion. We use all the same systems on a daily basis, so we are well-aware of the limits of the current technology. NSF is involved in a major merit-review modernization effort that will include analysis and upgrades of system processes, so we expect that some of the issues encountered will be resolved. The data analysis challenges are real and properly noted by the COV. There is an enormous amount of nuanced information available, so we tried to be very particular about the exact information parameter reporting so that the process was as transparent as possible.

C.5. Recommendation: As did the 2011 COV review, we urge that NSF make the review report template as flexible as possible. It would be useful to find a mechanism that would allow use of multiple computers (not just NSF's), and to find a way to make the report template shareable via in Google Docs or Drop box so all COV members could insert, revise, and edit (within control standards). A mechanism similar to that used for sharing panel summaries might suffice.

Response: Some options for collaborative document development are not available in the Federal context due to security concerns. But, as the NSF IT systems continue to evolve, we will share this recommendation and investigate what platform options and improvements are available.

C.6 Division-Specific Issues

C.6.1. Recommendation: It is necessary to first identify the skills that are necessary (at beginning, intermediate, senior levels) and to be specific about what the terms mean. The skills should be those appropriate to careers in fields outside of academia, but making use of one's scientific training and interest (and the "equipping" starts at pre-school). In addition:

- a. IOS should emphasize that integrative and collaborative research should be a goal of graduate training, as we move away from the single independent investigator model.
- b. IOS should continue to provide specific opportunities for cross-disciplinary re-training.
- c. Techniques, equipment, principles should be broadly shared; this might be accomplished by developing more inclusive web-based activities, etc.
- d. Travel and sabbatical grants that emphasize collaborative and integrative research could be provided.
- e. Broader Impact statements that emphasize best practices in education and other relevant areas should be encouraged.
- f. IOS could take the lead in BIO in emphasizing the employment of integrative and cross-disciplinary skills in a broader range of opportunities within and outside of academia, including those developed by NSF.

Response: We concur on all counts with these suggestions by the COV. Especially in light of recent data suggesting that well less than 10% of PhDs eventually secure jobs in academia, promoting a broader and more relevant experience base is an obvious need. Cross-disciplinary training, public-private partnerships, international science and engineering, and collaborative research are all priorities areas for IOS, BIO, and NSF as a whole.

C.6.2. Recommendation: The new pre-proposal, once a year evaluation system has created quite a bit of angst within the research community. A major reason for this anxiety is that it would take two years to obtain funding, at the minimum, if a pre-proposal is not selected for a full proposal or, even if selected, it is not awarded. Two years is especially hard for new faculty because of their limited timeline for acquiring funding. The COV recognizes CAREER awards are not limited by the preproposal process, so young faculty have a "safety valve" for keeping projects in the review process. IOS should continue to promote this alternative to the community. We also recognize the average timeline for funding was close to two years in the old system, a number the POs should also note to the community.

Response: We appreciate the suggestion and will certainly continue to promote the CAREER submission option for all eligible faculty members. As noted by the COV, the real driver of time-to-award is the amount of funding available to support new awards. Where resources are limited and demand is increasing, extended intervals are unavoidable. Some of the old standards and expectations (e.g., multiple active Federal awards before tenure) may simply not be realistic for most faculty in the modern climate. IOS and NSF will do what we can, but we also encourage COV members, and other community members, to engage in their own campus discussions about reasonable and responsible funding expectations.

C.6.2. Recommendation: Pre-proposal panels have been an issue at times because of the high number of proposals each member reviews. In addition, panel reviewers can be inconsistent by focusing on the big picture, yet still drilling down to methodological details to ask if a PI can achieve goals. The COV recommends that the POs continue to train both the PIs and the panelists to write and to evaluate the shorter pre-proposal format.

Response: We are actively engaged in advising both reviewers and PIs about (pre)proposal formats and expectations. We concur with the COV observation that not all reviews are entirely consistent. Where subjective and speculative evaluations need to be made, as in peer-review, some measure of inconsistency is unavoidable. We will continue our advising and outreach activities to try and make preproposal expectations more clearly defined for all.

C.6.2. Recommendation: The prohibition from adding Co-PIs for the full proposals seems counter-productive. Projects selected for full proposals still get critical comments from the pre-proposal panel that should be addressed in the full proposal. Sometimes

the best response to a critical need might require the addition of a Co-PI with expertise in a highly technical area to convince a panel that part of the project can be achieved. PIs should have the freedom to add an additional Co-PI in some cases.

Response: There is not currently an explicit prohibition against adding Co-PIs to invited full proposals. The example offered by the COV (a critical need is identified and highlighted by the panel), is actually quite common. In these circumstances, the PIs are encouraged to contact the managing Program Director to seek approval for such changes, as directed in the IOS core programs solicitation NSF 13-600:

“The full proposal should not deviate substantially from the preliminary proposal in the scope of the project or the list of personnel without prior written approval of the relevant Program Director. However, incorporating useful suggestions from reviews of the preliminary proposals is encouraged.”

We will work to clarify such language in our invitation letters to PIs, and during our outreach activities.

C.6.2. Recommendation: The COV recommends that IOS continues to engage the research community in discussions about fine tuning the pre-proposal process.

Response: We fully concur with this recommendation and have initiated our panelist surveys for exactly this reason. We look forward to optimizing the system with community involvement.

C.6.3. Recommendation: Again, Program Officers need time to work together to assess how to efficiently balance core program support of emerging science, and the implementation of new empowering initiatives. The working groups that have been discussed seem to be the appropriate vehicles for discussion, but we are concerned that POs have little time to think through means of identifying and facilitating new ideas and emerging sciences. In fact, we worry that too frequent statements of new initiatives that then exist for only very short periods may occur, given the breadth of the core programs. New initiatives should lead to significantly new science. There are many kinds of opportunities that IOS could develop, but, again, they must be judicious about outcomes and impacts. We think of a diversity of examples, such as:

- 1) Promote workshops that bring together international leaders in development of research tools and techniques, bioinformatics, etc. such that methodologies can be interchangeable.
- 2) Promote integrative research across disciplines, taxa, and techniques by bringing together "unanticipated" areas that could form collaborations, e. g. nanobiology in ecological research, micro C-T scanning at multiple scales for paleontologists, systematists, developmental biologists, and ecologists (both plants and animals).
- 3) Promote the connection of IOS with large initiatives such as NEON.

Response: Balancing new activities and core programs is indeed a challenge. The time available for thoughtful analysis of our programs is a function of both the number of people involved and the number of competing activities. To a very large extent, the preproposal process was designed to specifically enhance the opportunity for careful deliberations about future program directions, and to provide IOS staff with a more manageable work flow. Although, the total number of proposal actions is increased, the work-flow is streamlined to create a window of opportunity for such analyses and discussions.

C.6.4. Recommendation: As COV 2011 suggested, outcomes (e.g. final reports) for NSF awards should be evaluated. In addition, we suggest gathering data from a selected set of awardees 5 and 10 years post award, asking about the impact of a) the awards on their research development, and b) of their research on major, current scientific and societal concerns. Quantitative and qualitative data and descriptive accounts could be gathered for assessment. IOS should do more to encourage its community to communicate the value and impact of organismal biological research on both scientific dimensions and on societal issues. We suggest that Highlights (including more from IOS) be much more actively and widely circulated, perhaps to people and agencies on NSF lists, institutions receiving support, professional societies, etc., with the recommendation that they be used to help to educate the public and policy-makers. Tools are available to tabulate appearances and responses, such as online hits per Highlight. In addition, we congratulate IOS program analysts on their development of analytical tools. We encourage them to continue to develop new tools, collaborate with other analysts, and share these tools across NSF.

Response: We fully concur that a more detailed analysis of program impacts is both necessary and highly desirable, and as noted above are actively involved in developing tools for this analysis. The NSF annual report system changed recently and now has more accessible data (e.g., XML compliant standards were used), so we expect that our ability to understand and document our impacts will improve as the data builds in the new system. More targeted retrospective analyses and manual data mining are also possible and will be carried out in the coming years. Better utilization of the Highlights, the IOS Blog, and similar venues for communication of impacts will be emphasized by Division leadership in response to the COV suggestion.

Highlights are currently shared with the public by OLPA on the website "[Science, Engineering and Education Innovation](#)" (SEE Innovation), a section of Research.gov. They are also marketed via NSF social media and used in various reports throughout the agency becoming the basis for Science 360, RSS feeds and social media posts.

C.6.4. Recommendation: We close by commending IOS for serving the integrative biology community efficiently and effectively. This is true especially given the increasingly difficult funding climate, which has resulting record low funding rates. We want to emphasize that the major obstacle for IOS in achieving its goals is funding constraints.

Response: We sincerely appreciate the praise offered by the COV and would also like to close by thanking all the members for their hard work, thoughtful comments, and constructive suggestions.