CORE QUESTIONS and REPORT TEMPLATE
for
FY 2018 NSF COMMITTEE OF VISITOR (COV) REVIEWS

Guidance to NSF Staff: This document includes the FY 2017 set of Core Questions and the COV Report Template for use by NSF staff when preparing and conducting COVs during FY 2017. Specific guidance for NSF staff describing the COV review process is described in the "COV Reviews" section of NSF's Administrative Policies and Procedures which can be obtained at https://inside.nsf.gov/tools/toolsdocuments/Inside%20NSF%20Documents/COV%20Policy%20and%20Procedures%20070915.pdf [1].

NSF relies on the judgment of external experts to maintain high standards of program management, to provide advice for continuous improvement of NSF performance, and to ensure openness to the research and education community served by the Foundation. COV reviews provide NSF with external expert judgments in two areas: (1) assessments of the quality and integrity of program operations; and (2) program-level technical and managerial matters pertaining to proposal decisions.

The program(s) under review may include several sub-activities as well as NSF-wide activities. The directorate or division may instruct the COV to provide answers addressing a cluster or group of programs – a portfolio of activities integrated as a whole – or to provide answers specific to the sub-activities of the program, with the latter requiring more time but providing more detailed information.

The Division or Directorate may add questions relevant to the activities under review. Copies of the report template and the charge to the COV should be provided to OIA prior to forwarding to the COV. In order to provide COV members adequate time to read and consider the COV materials, including proposal jackets, COV members should be given access to the materials in the eJacket COV module approximately four weeks before the scheduled face-to-face meeting of the COV members. Before providing access to jackets, the Conflict of Interest and Confidentiality briefing for COV members should be conducted by webinar, during which, NSF staff should also summarize the scope of the program(s) under review and answer COV questions about the template.

Suggested sources of information for COVs to consider are provided for each item. As indicated, a resource for NSF staff preparing data for COVs is the Enterprise Information System (EIS) -Web COV module, which can be accessed by NSF staff only at http://budg-eis-01/eisportal/default.aspx. In addition, NSF staff preparing for the COV should consider other sources of information, as appropriate for the programs under review.

For programs using section IV (addressing portfolio balance), the program should provide the COV with a statement of the program's portfolio goals and ask specific questions about the program under review. Some suggestions regarding portfolio dimensions are given on the template. These suggestions will not be appropriate for all programs.

Guidance to the COV: The COV report should provide a balanced assessment of NSF's performance in the integrity and efficiency of the ***processes*** related to proposal review. Discussions leading to answers of the Core Questions will require study of confidential material such as declined proposals and reviewer comments. ***COV reports should not contain confidential material or specific information about declined proposals.*** The reports generated by COVs are made available to the public.

We encourage GOV members to provide comments to NSF on how to improve in all areas, as well as suggestions for the GOV process, format, and questions. For past GOV reports, please see http://www. nst.gov/od!oia!activities/cov!

[1] This document has three parts: (1) Policy, (2) Procedures, and (3) Roles & Responsibilities.

FY 2018 REPORT TEMPLATE FOR NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV: June 6-8, 2018

Program/Cluster/Section:

Division: Integrative Organismal Systems (IOS)

Directorate: Biological Sciences (BIO)

Number of actions reviewed: 426

Awards: 72

Declinations: 156

Invited Preliminary Proposals: 75

Not Invited Preliminary Proposals: 100

Other: 23

Total number of actions within Program/Cluster/Division during period under review: 13,145
Awards: 1,725

Declinations: 3,149

Invited Preliminary Proposals: 1,782

Not Invited Preliminary Proposals: 5,497

Other: 992

Manner in which reviewed actions were selected: A jacket sample of 426 competitive awards and declines were selected for COV review by a process described below[1]

The COV will be able to access the sample jackets via the COV module on eJacket. In addition, eJacket contains a list of all 13,145 actions reviewed by the Program over the last three years, including supplements, proposals returned without review, and withdrawn proposals. The COV can request to see any proposal on this list during the meeting. However, COV panelists will not have access to jackets/proposals for which they are in conflict. For the convenience of the COV, a list of commonly used acronyms is available in the DOCUMENTS section of the eJacket COV Module.

[1] The IOS COV team gathered data on the 13,145 IOS actions that were either managed by the Plant Genome Research Project (PGRP) Cluster and initiated between October 1, 2012 and September 30, 2017 (FY2013-FY2017) or were managed by the other program clusters within IOS (IOS Core) and initiated between October 1, 2013 and September 30, 2017 (FY2014-FY2017). 787 of these actions were excluded from consideration for the sample set. An explanation for how why these actions were excluded is included below.

The remaining 12,358 actions were then sorted into groups based on whether they were managed by PGRP or the IOS Core and by fiscal year received or initiated. 5% of Award actions for lead proposals were randomly selected within each fiscal year and for each management group. If a randomly selected Award was the lead proposal on a collaborative project, each non-lead proposal in the project was included as well. The randomly selected 5% of PGRP Awards amounted to 14 Awarded lead proposals while the 5% of IOS Core Awards amounts to 51 Awarded lead proposals and 7 associated non-lead Awarded proposals.

A similar process was used to select 5% of PGRP Decline actions and 5% of IOS Core Decline actions from each fiscal year. The 5% of PGRP Decline actions amounted to 29 proposals, while the 5% of IOS Core Decline actions amounted to 109 Declined lead proposals and 18 associated non-lead proposals. 5% of the eligible Returned Without Review (RWR) and Withdrawn proposals were also randomly selected from PGRP and IOS Core managed proposals within each fiscal year. This amounted to 4 RWR or Withdrawn proposals from PGRP and 19 from the IOS Core.

While the IOS COV team generally relied on random selection to avoid "cherry-picking" data, a few changes were made to the list of selected actions to make the sample set better represent the distribution of actions across IOS program clusters and to ensure the inclusion of special proposal types. After Award, Decline, RWR, and Withdraw actions were randomly selected from each fiscal year, the IOS COV team checked the distribution of each type of action across IOS program clusters. In a few cases where clusters were severely over or under-represented in certain fiscal years, actions from overly represented clusters were randomly selected for removal and replaced by randomly selected actions from under-represented clusters. EAGER awards were also added so that this program would be better represented in the sample set.

COV Membership

	Name	Affiliation
COV Chair or Co-Chairs:	Sunny Boyd	University of Notre Dame
COV Members:	Susan Gregurick	NIH/NIGMS; *BIO Advisory Committee Liaison*
	Richard Amasino	University of Wisconsin
	Gregory Ball	University of Maryland
	Elizabeth Brainerd	Brown University/Friday Harbor Laboratory
	Erika Edwards	Yale University
	Cassandra Extavour	Harvard University
	Anne Fennell	South Dakota State University
	Michael Grusak	USDA/ARS Fargo
	Daniel Hahn	University of Florida
	Gretchen Hofmann	University of California, Santa Barbara
	Ellen Ketterson	Indiana University
	Carole LaBonne	Northwestern University
	Robert Last	Michigan State University
	Lynn "Marty" Martin	University of South Florida
	Carlos Martinez del Rio	University of Wyoming
	James Moroney	Louisiana State University
	Nipam Patel	University of California, Berkeley
	Scott Poethig	University of Pennsylvania
	Zuleyma Tang-Martinez	University of Missouri-Saint Louis
	Nathan Urban	University of Pittsburgh
	Joy Ward	University of Kansas
	Walt Wilczynski	Georgia State University

MERIT REVIEW CRITERIA

An understanding of NSF's merit review criteria is important in order to answer some of the questions on the template. Reproduced below is the information provided to proposers in the Grant Proposal Guide about the merit review criteria and the principles associated with them. Also included is a description of some examples of broader impacts, provided by the National Science Board

1. Merit Review Principles
These principles are to be given due diligence by PIs and organizations when preparing proposals and managing projects, by reviewers when reading and evaluating proposals, and by NSF program staff when determining whether or not to recommend proposals for funding and while overseeing awards. Given that NSF is the primary federal agency charged with nurturing and supporting excellence in basic research and education, the following three principles apply:

- All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.

- NSF projects, in the aggregate, should contribute more broadly to achieving societal goals. These broader impacts may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified.

- Meaningful assessment and evaluation of NSF funded projects should be based on appropriate metrics, keeping in mind the likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful. Thus, assessing the effectiveness of these activities may best be done at a higher, more aggregated, level than the individual project.

With respect to the third principle, even if assessment of Broader Impacts outcomes for particular projects is done at an aggregated level, PIs are expected to be accountable for carrying out the activities described in the funded project. Thus, individual projects should include clearly stated goals, specific descriptions of the activities that the PI intends to do, and a plan in place to document the outputs of those activities. These three merit review principles provide the basis for the merit review criteria, as well as a context within which the users of the criteria can better understand their intent.

2. Merit Review Criteria
All NSF proposals are evaluated through use of two National Science Board approved merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two merit review criteria are listed below. Both criteria are to be given full consideration during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Therefore, proposers must fully address both criteria. (GPG Chapter II.C.2.d.(i) contains additional information for use by proposers in development of the Project Description section of the proposal.) Reviewers are strongly encouraged to review the criteria, including GPG Chapter II.C.2.d.(i), prior to the review of a proposal.

When evaluating NSF proposals, reviewers will be asked to consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, reviewers will be asked to evaluate all proposals against two criteria:

- **Intellectual Merit**: The Intellectual Merit criterion encompasses the potential to advance knowledge; and

- **Broader Impacts**: The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

The following elements should be considered in the review for both criteria:

1. What is the potential for the proposed activity to:
a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
b. Benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or organization to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

3. Examples of Broader Impacts

The National Science Board described some examples of broader impacts of research, beyond the intrinsic importance of advancing knowledge.[2] "These outcomes include (but are not limited to) increased participation of women, persons with disabilities, and underrepresented minorities in science, technology, engineering, and mathematics (STEM); improved STEM education at all levels; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a globally competitive STEM workforce; increased partnerships between academia, industry, and others; increased national security; increased economic competitiveness of the United States; and enhanced infrastructure for research and education. These examples of societally relevant outcomes should not be considered either comprehensive or prescriptive. Investigators may include appropriate outcomes not covered by these examples."

[2] NSB-MR-11-22

INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, returns without review, and withdrawals) that were *completed within the past four fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program(s) under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

I. Questions about the quality and effectiveness of the program's use of merit review process. Please answer the following questions about the effectiveness of the merit review process and provide comments or concerns in the space below the question.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: • The mean reported in the Self Study is about 3.3 reviews per proposal over the review period, but this mean includes preproposals that received just 3 panelist reviews. In our sub-sample of 426 proposals, the mean is 4.6 reviews for full proposals reviewed by one panel. Proposals reviewed by 2 panels had 7-9 reviews. It appears that about 10% of panel-reviewed proposals received only one ad hoc, which is a small proportion. Even so, **the opinion of the COV is that all proposals should receive two or more ad hoc reviews to balance the panel reviews.** We know that it can be challenging for Program Directors (PDs) to get ad hocs, and **we encourage NSF to continue to improve its tools for managing the review process** (similar to the excellent tools available for managing journal peer reviews). • PIs may be surprised that their proposals receive as few as 3 or as many as 9 reviews. The context statements do not address this variation, and we were not given information on the distribution of this variation across different types of proposals, applicants, or funding success rates, consequently we could not assess the extent of the variation or its potential impact. **Perhaps PIs could be informed in context statements that proposals receive at least 3 reviews, and proposals that are co-reviewed by more than one panel are expected to have a larger number of reviews.** • Panels were in-person, hybrid or virtual. The COV asked the PDs about these panel types. The PDs report that:	YES

○ Hybrid panels work very well and offer the opportunity for panelists who cannot or prefer not to travel to participate. ○ Virtual panels work well for small panels (8-10 panelists). ○ Virtual panels do not work well when there are larger numbers of panelists. ○ In-person panels provide valuable social interactions and networking opportunities, particularly for more junior panelists. They also provide more opportunities for panelists to interact informally with the PDs and learn about NSF. **The COV recommends that in-person panels should not be eliminated, but the addition of hybrid and small virtual panels is valuable.** • Some proposals are reviewed internally by PDs, and not by panels. Examples include RAPID, EAGER, INSPIRE, Creative Extensions, Meeting/Conference and supplements. In our sample of 426 proposals, 72 were funded: 27 of those were reviewed with no panel (38%), 42 in one panel (58%) and 3 in 2 panels (4%). Although 38% of awards were reviewed internally, these awards represent a small percentage of the total dollars awarded. • The funding rate for these internally-reviewed proposals was 80% (27/33). The high funding rate results from a PD pre-review that is done when PIs inquire about these internally-reviewed opportunities. PIs are only encouraged to apply if the PD(s) think the proposal is fundable. Including these internally-reviewed proposals inflates the apparent funding rate which is listed as 23% in the IOS Self Study, but the COV was informed that the funding rate for panel-reviewed proposals is under 10%. **The 23% value is misleading and should not be emphasized in public statements about the IOS funding rate.** • There is a perception among some COV members that panel reviews carry more weight than ad hoc reviews. In their meeting with the COV, the IOS PDs said that they do not weigh panel reviews more highly than ad hocs; the review types are complementary -- panelists tend to be generalists and ad hocs are selected as specialists. Based on their own panel experiences, however, some COV members think that the panelists and panel reviews carry more weight in the ranking and panel summary. In some cases, the PDs seem to provide counterbalance to this panel weight in their own decision-making (based on the Review Analyses in eJackets). **The COV supports this role for PDs -- providing oversight to ensure that panel and ad hoc reviews receive equal weight.** **Data Source: EIS/Type of Review Module**	
2. Are both merit review criteria addressed a) In individual reviews? Yes, both criteria are nominally addressed because the review form requires at least 5 words for both Intellectual Merit (IM) and Broader Impacts (BI). Most reviews provide some substantive comments about	YES

the BI, but these were often less substantive than those on the IM. In our sample of reviews from 2013-2017, the comments on BI have generally become longer and more substantive. b) In panel summaries? Yes, both criteria are addressed because the panel summary form requires comments for both IM and BI. Most panel summaries provide some substantive comments about the BI, but these were often less substantive than those on the IM. In our sample of panel summaries from 2013-2017, the comments on BI have generally become longer and more substantive. c) In Program Officer review analyses? Yes, the Program Director Review Analyses nearly always provide substantive and informative comments on both BI and IM. **Data Source: Jackets**	

3. Do the individual reviewers giving written reviews provide substantive comments to explain their assessment of the proposals? Comments: • Most of the time, yes. But the rationale for the rating can be hard to glean from the reviews. • Some COV members are concerned that reviewers do not sufficiently evaluate productivity from prior NSF support, where appropriate. • The reviews hardly ever evaluate the Data Management Plan. • It is good that the review form includes separate boxes for IM and BI, but the "Summary Statement" box is vague. Reviewers do not consistently use this box to provide their rationale for their rating. In many of the reviews that we examined, the summary statement was used to simply summarize the scope of the proposal (which is a function already served by the "synopsis" section of the panel summary) without reference to the proposal rating, or to restate what reviewers considered the most important strength or weakness of the proposal. **We recommend that specific guidance as to the purpose of the reviewer summary statement, and what the summary statement should and should not contain, be provided explicitly to reviewers.** This is particularly important in the cases of proposals that are not discussed, as no panel summary is generated for such proposals, reducing the feedback that PIs can receive on their proposals. • **The COV's opinion is that the review form could provide even more guidance about criteria and parts of the proposal that need review.** For example, these could include, but need not be limited to, the following: productivity from prior support, Data Management plan, significance of question(s) asked, potential for innovation, appropriateness and feasibility of proposed methodology, or potential for impact on the field. Some COV members suggest	YES and NO

that numerical scores for different sections would be valuable (more similar to NIH reviews). Other COV members suggest separate text rating (E, V, G, etc.) and separate Rationale section for IM and BI. **Data Source: Jackets**	
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: • The IOS Panel Summary template includes a Rationale for Panel Rating, and most of the time these sections are fairly clear. • However, the Rationale for Panel Rating sections are not uniformly informative. **The COV recommends that panel members drafting these sections should continue to be educated about how to write a good rationale, and the other assigned reviewers and panel members should be encouraged by the PD to look carefully and improve the Rationale sections.** • The Rationale for Panel Rating sections generally do not address low reviews in highly ranked proposals or high reviews in low ranked proposals. The PD Review Analysis documents are required to address high and low review ratings and this requirement provides valuable information for PIs. PIs can be frustrated when their proposal receives mostly high reviews but is ranked lower by the panel. **The COV recommends that the Rationale for Panel Rating sections should address review ratings that are inconsistent with the final panel ranking.** • Some COV members are concerned that panels do not sufficiently evaluate past productivity from prior NSF support. • The more recent panel summaries do include some statement about the Data Management Plan, but these are usually not substantive. **Data Source: Jackets**	YES and NO
5. Does the documentation in the jacket provide the rationale for the award/decline decision? [Note: Documentation in the jacket usually includes a context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.] Comments: • Yes. The jacket includes all reviewer reports, panel summary, correspondence, diary notes and Review Analysis written by the PD. Collectively these documents form the basis for the funding recommendation, which is a strength of the eJacket system. • The PD Review Analyses are particularly thorough and exemplary, explaining clearly the rationale behind award/decline recommendations. These Review Analyses are notably more	YES

informative than the other elements of the eJackets, and are more balanced with respect to discussing both review criteria, than are reviewer reports or panel summaries. **The COV commends IOS PDs for this thorough documentation and encourages them to continue their excellent work in this regard.** **Data Source: Jackets**	

6. Does the documentation to the PI provide the rationale for the award/decline decision? [Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written in the PO Comments field or emailed with a copy in the jacket, or telephoned with a diary note in the jacket) of the basis for a declination.] Comments: • For the most part, yes. However, there are a noticeable number of proposals whose reviewer reports and Panel Summary statements do not sufficiently explain the basis for the award/decline decision. In order to understand this decision, PIs need to be able to know not just what elements of their proposal were considered strengths and weaknesses, but also which of these elements were considered most important when making the final decision. Reviewer reports, their summary statements, and panel summaries were inconsistent in this regard. Some focused only on strengths, some only on weaknesses, and many reports mentioning both strengths and weaknesses did not explain whether or not these were considered of high concern. • We closely examined all reviews, summary statements, and panel summaries of 10 jackets of proposals that were not funded. In this sample, 83% of the reviewer reports explicitly described both strengths and weaknesses of the IM of the proposal. However, only 33% explicitly addressed both of these for the BI of the proposal. Only half of the reviewer reports were explicit about whether the strengths and/or weaknesses described were major influences in the final rating given to the proposal by that reviewer. • Within the sample described above, for only 10% (1 out of 10) of proposals did PIs receive additional information from the PD about the rationale behind the funding recommendation, which appeared to be an email from the PD in response to a query from the PI. This suggests that it may be the case that PIs are not sufficiently aware or taking advantage of the opportunity to contact PDs directly to obtain more information on funding decision rationales. • **For all of the reasons outlined here and in point (5) above, we recommend that more of the rationale that the PDs explain so well in their Review Analyses, be communicated to the PIs.**	YES and NO

Data Source: Jackets	
7. Additional comments on the quality and effectiveness of the program's use of merit review process: Through the review process, IOS has an opportunity to strengthen the culture of good data management and data sharing within the IOS fields**. At the review, Panel Summary and PD Analysis levels, IOS should strive for substantive evaluations of Data Management Plans. In the Results from Prior NSF Support and in Annual/Final Reports, the implementation of Data Management Plans and actual data sharing should be evaluated.** The COV discussed what happens when proposals are resubmitted after being declined. Officially all proposals are new submissions, so there is no mechanism for panelists to be given a history of prior reviews. However, in practice it is clear that some PIs modify previously submitted proposals in response to reviewer and panel comments, and submit these revised proposals. Some PIs include a narrative of prior review scores, reviewer and panel criticisms, and how they have been addressed in the current version. But this is not required, nor does it seem to be described in any proposal instructions. **It is the opinion of the COV that there should be a uniform process in place to inform PIs that they may include information on prior reviews, if they chose to do so.**	

II. Questions concerning the selection of reviewers. Please answer the following questions about the selection of reviewers and provide comments or concerns in the space below the question.

SELECTION OF REVIEWERS	YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: Despite the challenge presented by a large number of proposals (and preproposals under the previous review system), the Division has done an excellent job of recruiting knowledgeable reviewers for its proposals. Most of the examined jackets had a good balance of reviewers who were central to the topic area of the proposal and others who were knowledgeable generally, and provided a broader perspective. In some cases, it was not apparent that an individual closely connected to the science served as a reviewer, which may have been related to COIs with the application. However, when those reviews were examined it was apparent that they were of high quality with specific and consistent comments. The number of reviews per application averaged 3.2 (including the preproposals that were reviewed only by three panelists), with a modal number of 4 in the full proposal jackets reviewed (which would normally consist of 2 panelists and 2 ad hoc reviewers). The COV was not concerned about the number of reviewers per application, but did express considerable concern about the variance in reviewer number across full proposals. The COV recognized that large, complex, and/or multidisciplinary proposals do require the expertise of multiple reviewers, but the high variance was not explained by this consideration. **Consistency in the review process, and its impact on fairness, is important, and we urge the Division to consider mechanisms to limit the variability in the number of reviews per proposal.** **Data Source: Jackets**	YES
2. Did the program recognize and resolve conflicts of interest when appropriate? Comments: A review of the sample of the Division jackets in addition to the data presented in the Self Study indicate that the Division has an effective process for identifying COIs in potential ad hoc reviewers and panel members, and for excluding them from participating in the review of proposals. Based on the number of COIs it does not seem as though a meticulous adherence to COI policy has significantly limited the ability to conduct effective reviews. However, we do suggest that the Division consider how broadly some of the current COI categories are defined,	YES

and how they might limit the availability of otherwise appropriate reviewers in light of an increase in collaborative research, interactions among universities and researchers at different universities, and large multi-author publications, as well as emerging areas of science that involve a relatively small but highly interactive community of scientists. **The 2014 COV report noted the issue of COI interpretations potentially affecting reviewer availability negatively, and the current COV did not have the impression that the issue has been addressed.** **Data Source: Jackets**	
3. Additional comments on reviewer selection: Concerns about the impact of the preproposal system on reviewer availability and workload noted in the previous COV report are now moot given the abandonment of that system. The new "no-deadline" system will come on line shortly. It is incumbent on the Division to consider how the new system may impact availability or nature of reviewers and monitor this carefully as this new system is implemented.	

III. Questions concerning the management of the program under review. Please comment on the following:

MANAGEMENT OF THE PROGRAM UNDER REVIEW
1. Management of the program. Comments: **IOS is a scientifically high impact division that is centrally important to the overall mission of the BIO Directorate and the NSF overall. The COV believes that it needs strong stable leadership to continue to succeed in its mission. The COV was nonetheless impressed at how well the program directors and staff have functioned in promoting the mission of IOS despite the lack of stable leadership over the review period.** As in the prior 2014 Committee of Visitors report, the Division continues to have a notably high rate of turnover in senior leadership positions. Moreover, consistent with the prior report, it appears that there continues to be fewer permanent program officers who have been in their roles for longer periods of time. Permanent employees bring institutional memory and ensure consistency and continuity in the programs and to the Division. Given the importance of strategic planning and strategic partnerships within the BIO Directorate and across the agency, the IOS Division would benefit from permanent leadership, either at the Division Director or Deputy Division Director level. **The COV recommends that the Division retain a permanent leader (Division Director or Deputy Division Director) and maintain a balance between rotating and permanent program staff that is consistent with the other Divisions within the BIO Directorate.** With the change to a no deadline submission policy, the COV believes that this could afford program officers time and opportunities to develop cross Division and cross-Directorate interactions. The COV noticed a lack of apparent cross-organizational discussions and opportunities. Given the nature of the NSF's laudable goal of discerning the *Rules of Life*, this question will require a scale of scientific inquiry that could be unprecedented, bringing together researchers from across the BIO Directorate and from different NSF Directorates. IOS could stand at the intersection of NSF to address this important goal and could play a pivotal role. **The COV recommends that the IOS Division utilize the no deadline submission policy as a method to set processes in place that will enhance co-review and co-funding of proposals that address key priorities of NSF.** With the addition of the Plant Genome Research Program, the IOS Division has broadened its scope and priorities. The COV notes that there could be unintended budgetary consequences and recommends that the Division continues to monitor and maintain a healthy balance of supporting larger team-based projects and independent investigator projects in all the clusters within this Division.
2. Responsiveness of the program to emerging research and education opportunities. Comments:

The BIO Directorate has responded to emerging research and educational opportunities through a variety of mechanisms, including Dear Colleague Letters, workshops and proposals submitted through EAGER and RAPID programs. Likewise, IOS utilizes these mechanism as well as strategic partnerships with for example, Bill and Melinda Gates (BREAD) and Simons Research Centers for Mathematics of Complex Biological Systems (MathBioSys). These strategic partnerships are a good method to address emerging research opportunities and IOS is to be commended for these activities.

The COV encourages IOS to develop a broader strategic vision that aligns with the priorities of the agency and the BIO Directorate. In discussions with NSF staff, program officers mentioned that other Divisions hold retreats and the COV encourages this avenue for planning purposes. Without strategic goals, it is difficult for the community to understand the priorities and metrics of success for this Division. Having strategic goals that link to the NSF plan will allow IOS to make a more powerful case for its priorities within NSF to external stakeholders. Tying to these larger initiatives will be key for enhancing the critical areas of science that are core parts of the IOS mission and which are not being supported given the current funding rate of the IOS core research programs.

In addition, the COV notes that the Division does not appear to engage in programmatic evaluation in a critical way. Without critical program evaluation it is difficult to judge when and if programs have meet their goals.

The COV recommends that the Division develop strategic goals with metrics of success and a path for programmatic evaluation.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

Comments:

Program officers consider a wide range of factors when deciding which proposals to fund and have considerable autonomy when making these decisions, within the constraints of the priorities described in the program solicitation. We commend them for their effort to balance judgements about the quality of the proposed science with other considerations. Coordination between program areas is facilitated by frequent interactions between program officers and by the Division Director and the Deputy Division Director, who must approve all funding decisions. The COV believes that the priorities of IOS match the long-range priorities of NSF and the specific concerns of communities served by IOS. At the same time, the COV was concerned about the apparent lack of strategic goals for research across the division. The COV encourages IOS to develop such goals, both for the purpose of directing long term funding decisions and for articulating to the scientific community and to the broader public what IOS does. In particular, IOS needs to consider the appropriate balance between research on model/reference organisms and non-model systems and communicate this policy in program solicitations.

IOS is a critically important component of BIO, and the NSF overall. At the current funding rate of ~ 8%, far too much outstanding, highly meritorious science is being left on the table unfunded. This has detrimental consequences not only on the scientific research enterprise, but also in training and establishing the next generation of STEM researchers in this important area of focus. Looking forward, it will also hurt major NSF initiatives such as the *Rules of Life*, as organismal science lies at the nexus of any advances in this area.

4. Responsiveness of program to previous COV comments and recommendations.

Comments:

The program is sensitive to the concerns of the previous COV about administrative flux, and is working hard to solve this problem. Many of the permanent staff have served in various capacities, can move into different administrative positions when necessary, and can provide rotators with appropriate training. The administrative resilience of the program is remarkable.

The previous COV raised concerns about the lack of strategic goals for the entire division. As noted above, IOS has yet to develop such a vision. **This should be considered a high priority**.

The prior COV raised concerns about the use of virtual panels. In the intervening time IOS has developed reasonable practices and procedures for virtual panel usage. The COV feels this concern has been addressed.

The 2014 COV report noted the issue of interpretation of COI policies potentially affecting reviewer availability negatively, and the current COV did not have the impression that the issue has been addressed.

IV. Questions about Portfolio. Please answer the following about the portfolio of awards made by the program under review.

Programs should provide materials to the COV regarding portfolio goals and can insert specific targeted questions about their portfolios. *(Some dimensions of portfolio balance to consider include: balance across disciplines and sub-disciplines, award size and duration, awards to new and early-career investigators, geographical distribution of awards, awards to different types of institutions, innovative/potentially transformative projects, projects with elements of risk, inter- and multi-disciplinary projects, projects that integrate research and education, participation of groups that are under-represented in science and engineering, and projects that are relevant to agency mission or national priorities).*

The COV noted that IOS has been doing a meritorious job at balancing their awards portfolio, funding a range of exciting and important research. The COV encourages IOS to continue to be aware of the balance of their award portfolio. In addition, the COV noted that smaller awards (ranging from $50-150,000) could be important additions to the IOS portfolio. Here, members of the COV noted such smaller awards would be useful to a variety of investigators, ranging from Beginning Investigators to experienced PIs moving into new areas. It is again worth noting here that as a consequence of the 8% success rate IOS is unable to fund a significant amount of outstanding and important science.

1. Does the program portfolio have an appropriate balance of awards across disciplines and sub-disciplines of the activity?

As was explained to the COV by the acting director of IOS, the distribution of funds across the core IOS clusters is determined by an algorithm that considers both 1) the distribution of funds in previous years to maintain consistency and 2) the number of proposals received by the various clusters in the current year. In general, the IOS-wide portfolio is distributed well across clusters and panels.

The COV noted a large discrepancy in the budget and award size of the PGRP relative to core IOS programs and understands that the history of the PGRP complicates comparisons. Additionally, the higher funding rates of PGRP may be due to differences in proposal submission procedures during the evaluation period (PGRP rolling deadline; IOS pre-proposals) and so this also cannot be fairly compared. Similarly, the award sizes should not be compared directly, as PGRP does not award Collaborative Research projects, thus single awards often include multiple PIs with subawards. Finally, an attempt by the COV to characterize the types of awards made by PGRP in order to compare to typical IOS core awards proved difficult: we found awards with very significant budgets that were characterized as supplements, renewals, and creativity extensions, and very few award categorizations that seemed directly comparable to new, solicited, peer-reviewed proposals.

2. Are awards appropriate in size and duration for the scope of the projects?

There appears to be a slight but noticeable increase in average award size across years, though according to the self study (Figures 5A and 5B), this seems to be mostly driven by an apparent large increase in award size in FY 2016 in PGRP. Upon closer inspection by the COV, the large increase in the FY 2016 PGRP budget appears to be due to investigator institutional changes. In this light, award sizes seem surprisingly static across this time period, which is in contrast to the previous COV report. This is also in contrast to community expectations that the pre-proposal system would be biased in favor of larger, more collaborative projects, and a general trend of science becoming more expensive due both to new tools (genomic, imaging, etc) being available for a broader set of questions and increasing salaries for graduate students and post-doctoral associates. In a brief assessment of 15 jackets of awarded proposals, we found that salary comprised between 50-81% of

direct costs. In general, in our screened subset of awards, the scope of the projects were appropriately matched with their level of funding. Overall, we found that the level of funding was well-scoped for the work proposed in each project, that there was significant funding to support trainees, and a minority of the projects requested major equipment, suggesting that many PIs were leveraging existing resources at their institutions.

In addition, in an analysis by the COV members using data from the jackets (n=331; removing fellowships, DDIGs, and supplement awards), there was no difference in the distribution of requested budgets between awarded and declined proposals. This finding does not support the concern that reviewers are biased toward evaluating larger projects more favorably.

Data source: IOS Self Study and jackets

3. Does the program portfolio include awards for projects that are innovative or potentially transformative?

- Yes. The COV surveyed the available eJackets and noted funded projects that were designated as innovative or potentially transformative (IPT). The process for identification of these projects was described in the materials provided.
- While the value of innovative or potentially transformative research is recognized, it is unclear whether IOS has a goal for the percentage of funded proposals that are designated as IPT. IOS should determine whether a targeted percentage has value and whether there should be any linkage of this designation to the scale of the project. For example, should larger projects have higher expectation for innovation?
- IOS should be more transparent about how the IPT designation factors into decisions about funding.
- Additional guidance/examples of what constitutes IPT proposals would be helpful to reviewers and to PIs.
- The relationship between risk and innovation should be clarified. While risk tolerance is important, reviewers should be sure to focus on innovation and potential for transformation, rather than focusing primarily on high risk, per se.

4. Does the program portfolio include inter- and multi-disciplinary projects?

The COV noted that there was a reasonable degree of inter- and multidisciplinary projects, as self-reported by the PI. Here, during the review period from 2012-2014, awards report 25% and 10% of projects involved 1 or 2 other areas outside BIO, respectively. Many fewer projects involved 3 other areas (3% of reporting projects). Areas typically noted as collaborating fields were computer science and physical sciences such as chemistry and physics, in addition to mathematics and engineering. As an indicator of the expanding multidisciplinary aspect of the IOS portfolio, co-reviews across all directorates have increased from 45 in 2015 to 119 in 2017 (Table 12, IOS Self Study). In our deliberations, we noted IOS's growing collaborative nature across Bio and the Foundation as a strength of the group. This activity has elevated the quality of review in other programs, and has leveraged funds from other programs to co-fund IOS awards.

The COV recommends that IOS also track the interactions within BIO, in that collaborations between, for example, geneticists and ecologists would reflect an equally strong and important interaction for the advancement of the field. The COV also noted that areas in the *10 Big Ideas*, such as the *Rules of Life*, will require focus on co-funding efforts in the future (e.g., crossing boundaries between molecular biology and IOS), beginning as soon as FY 2019 when the *Rules of Life* funding may become available. An example of this activity in the past is the

collaborative effort with GEO to develop awards to study ocean acidification. **The COV encourages IOS Program Directors to reach out to other programs in BIO to facilitate the process of IOS grantees having access to these future funds allocated to the *Rules of Life*.**

Data source: IOS Self Study

5. Does the program portfolio have an appropriate geographical distribution of Principal Investigators?

For questions 5-9 that deal specifically with portfolio balances, the COV struggled to answer these questions with only the data provided in the self-study. In the self-study report, only percentages of final awarded projects were presented, whereas we felt strongly that the major parameter that should be evaluated is relative success rate of different subgroups. In other words, it is hard to ascertain whether the final portfolio of awards is "balanced" if there is no indication of the distribution of original proposal submissions across various groupings of the population. We attempted to estimate success rates for the various groups with significant help from on-call staff; due to various complexities in proposal categorization and organization, we are unsure if we have evaluated precisely the same set of proposals as presented in the self-study. **For future COV evaluations, we strongly recommend reporting success rates in addition to final portfolio distributions.**

Please note that "success rates" reported in the answers to questions 5-9 below are not final success rates of awarded proposals; rather, these numbers are only the rates of successful progression through the proposal evaluation process. For IOS core programs that comprise the majority of IOS funding, this involves first submission of pre-proposals, only a fraction of which are invited to the full proposal stage, and then submission of full proposals, only a fraction of which are recommended for funding. ***As noted above, the actual success rate of core program proposals for the IOS is approximately 8% for all programs, which the COV considers as unacceptably low, as it is detrimental to the advancement of the national interests.***

The IOS programs funded proposals from two territories and 49/50 states. There was a large variation in the number of successful preproposals by state. However, this variation is largely due to the number of preproposals submitted as the number of submissions varied between eight and 607 preproposals.

Overall, the COV thought that IOS is doing a good job of distributing research money throughout the country. However, IOS needs to provide more and clearer data on the geographic distribution of awards for future COV panels. The COV also discussed what the "appropriate" geographical distribution of PIs might be, and suggest that NSF provide more guidance as to the goals they are trying to achieve.

Data source: IOS Self Study & additional data gathered by the COV with assistance from IOS data analysts.

6. Does the program portfolio have an appropriate balance of awards to different types of institutions?

For the years 2014-16, the majority of the proposals and preproposals came from PhD-granting institutions. When considering lead institution, 85% of the pre-proposals came from PhD granting institutes. Of these submissions, 87% of the PIs and co-PIs on successful pre-proposals came from PhD-granting institutions. This drops a bit for awarded full proposals as 80% of the PIs and co-PIs on funded awards came from PhD-granting institutions. The non-academic private institutes

appeared to have a higher success rate submitting roughly 5% of the total preproposals but accounting for 8% of the funded awards. PIs and co-PIs from bachelors and masters granting institutions are involved in about 10% of the preproposal submissions and are involved in about 10% of the funded awards. So when considering PIs and co-PIs, scientists from bachelors and masters granting institutions are faring as well as PhD granting institutions. Overall, the mix of institutions receiving awards from IOS closely reflects the initial mix of submissions.

However, when one looks at the lead institutions the picture is a bit different. For PhD granting institutions, the overall success rate was about 7.5% for the three years from 2014-16. However, for the same period, the overall success for bachelors or masters-granting institutions is only 4%. In addition, the number of awarded proposals with a bachelors or masters granting institution as the lead institution was low, with an average of only four per year from bachelor-granting institutions and seven per year for master-granting institutions. This compares to an average of 135 per year when a PhD granting school was the lead institution.

The COV recommends that the IOS division encourage more proposals from bachelors and masters-granting institutions. The number of preproposal and full proposals from these schools appeared to be small. We note that this was also recommended in the previous COV report.

Data source: IOS Self Study & additional data gathered by the COV with assistance from IOS data analysts.

7. Does the program portfolio have an appropriate balance of awards to new and early-career investigators?

Beginning Investigators (BIs) fared well during the years of the pre-proposal program in IOS (2014-2017; Table 14 IOS Self Study). Here, 25-28% of successful pre-proposals were from BIs (Table 14), though our calculations of success rate (invited as a percentage of submitted) was slightly less (BI: 21%; non-BI: 25%). Success rates of full proposals leveled to similar levels between BI and non-BI (Table 14). This further supports the initial findings from the previous COV that, contrary to initial concerns, the move to a pre-proposal system did not bias proposal evaluations against BI submissions.

CAREER proposals are often considered to be good opportunities for BIs, due to their requirement that PIs must not be tenured faculty. However, the COV discovered that BIs had lower success rates with CAREER proposals than non BIs (12% vs 17%), indicating that slightly more experienced PIs with at least one awarded external grant are more competitive for this early career award.

The Division has done an excellent job of tracking funding to BIs, including using a data driven approach to analyze outcomes during the pre-proposal program. As a recommendation, the COV noted that as IOS transitions to the "no deadline" (no DL) data gathering should be continued as it was for the pre-proposal process (possibly including hiring a contractor to conduct a study). In particular, we encourage IOS to track the impact of no DL on the number of submissions and success in funding from PIs and co-PIs who would be impacted by caregiving and career/life balance.

Data source: IOS Self Study & additional data gathered by the COV with assistance from IOS data analysts.

8. Does the program portfolio include projects that integrate research and education?

- Generally, the portfolio has many projects that integrate research and education.
- We observed that some educational goals as described in proposals include a plan for assessment of educational objectives. We believe that having such assessment plans should be encouraged and that these plans should be reviewed, with comments provided in the reviewer summaries.
- When results of previous NSF support are included in a proposal, IOS is encouraged to ensure that reviewers are assessing the success of both the intellectual merit and broader impacts of the previous work.
- IOS should evaluate the success of educational programs at the programmatic level.
- The COV notes that the integration of research and education is usually introduced in a proposal as part of the broader impacts. IOS should consider the full range of possible broader impacts when communicating with reviewers; PDs should clearly articulate this full range. For example, IOS has recognized the importance of promoting the participation of women and underrepresented minorities in science, and in increasing public outreach and engagement with science. We suggest that IOS might also encourage other areas of broader impact, such as increased partnerships between academia and industry, enhanced infrastructure for research and education, and projects with potential economic benefits.

9. Does the program portfolio have appropriate participation of underrepresented groups?

Based on data in Table 16 in the IOS Self Study, PIs from underrepresented groups received from 7-10.7% of fully funded awards during the review period. Here, we found funding rates for minority PIs to be similar to non-minority PIs.

In addition, awards to female investigators was roughly 31-34% of total. Female PIs initially had higher success rates than males at the preproposal-invite stage (27.5% vs. 23% success rate for women vs. men, respectively), but had decreased success rates with awards for full proposals (27% vs. 30% success rate for women vs. men, respectively).

The COV recognized the role of IOS in the overarching goal of NSF to broaden participation of under-represented groups in science, technology, engineering, and mathematics (STEM). The COV noted that the staff of IOS had numerous outreach activities to various communities and institutions, and encourages the Division to continue their excellent work in this area. It would be important to consider policy and mechanisms of assessment of participation of under-represented groups in any future strategic visions and planning within the Division. As mentioned for the issue of geographic distribution of awards (#5 above), the COV noted that the goals of IOS and of the NSF as to what the "appropriate" proportion of "underrepresented" PIs might be, and what the appropriate definition of "underrepresented" is in this context, is unclear. Merely "broadening participation" is an overly simplistic and insufficient goal. **The COV recommends that the NSF develop more specific and explicit goals in this regard.**

Finally, we note that an integral consideration in answering this question and several others throughout this report, is that of the problematic categorization of "diversity." The COV recognizes the reality of societal discrimination based on race and other factors, and the need to eradicate discrimination and bias. We commend the IOS and the NSF in sharing this recognition, and support their continued furtherance of this goal through this and other questions throughout the report. However, the COV notes that it is now clear that "race" is no longer an acceptable scientifically valid category, but rather is a social construct. Indeed, the NSF has supported much of the genomic, genetic and social science research that has demonstrated this. As the governmental scientific foundation tasked with advancing science research and education, it is inconsistent for the NSF, and

the IOS within it, to continue to implicitly support these unscientific categories by tracking the "race" of PIs, staff, and other participants in the NSF's mission. **Accordingly, the COV does not recommend that the category called "race," as it is currently presented to PIs, be included uncritically as a category for tracking PI participation in IOS or NSF programs.** The "racial" categories offered as options are limited, inadequate for the current and projected future national demographic, historically biased, and most importantly, unscientific. **However, we do recommend that the NSF track self-reported ethnicity, socioeconomic status, and other personal identity elements, which are elements that can contribute to the reality of racism, across the individuals that participate in and enact the mission of the NSF.**

Data source: IOS Self Study & additional data gathered by the COV with assistance from IOS data analysts.

10. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs?

The US is poised to completely transform the economics and environmental impact of key industries such as the production of food, energy, building materials, and industrial chemicals. Knowledge from the biological sciences will play a key role in this transformation. While China and other countries are greatly increasing funding in the biological sciences, the flat funding in the NSF Biological Sciences Directorate, coupled to increasing costs of performing cutting edge science, has resulted in a decrease in the amount of science that can be supported. This is doing damage to the US research and education enterprise. For example, many of our most talented young people are not pursuing careers in science at a time when challenges in areas like food security are increasing. This concern was highlighted in the 2007 National Research Council report "Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future" and is more relevant than ever:

> "...vitality is derived in large part from the productivity of well-trained people and the steady stream of scientific and technical innovations they produce. Without high-quality, knowledge-intensive jobs and the innovative enterprises that lead to discovery and new technology, our economy will suffer and our people will face a lower standard of living."

IOS plays a central role in the mission of the Bio Directorate. This is because it supports biological science that addresses life at the organismal level—the level that defines areas such as how the microbiome affects the health of plants and animals, how a diverse range of organisms comprise a healthy ecosystem function, or how organisms will respond to changing ecosystems.

The COV notes that the funding levels of IOS core programs have severely limited the ability of IOS to contribute to our nation's ability to rise above this storm.

This centrality has been of increasing importance as science becomes more integrative and cross-disciplinary. This fundamental importance will only increase as NSF incorporates the *10 Big Ideas* into its organizational fabric. IOS has an especially important role to play in the *Growing Convergence* and *Understanding the Rules of Life* themes, and should provide especially important opportunities for linking Bio to other Directorates and US-wide and global initiatives related to *Harnessing the Data Revolution.* In this context, the COV is gravely concerned about the long-term flat IOS budget (only 8% of peer-reviewed proposals in core programs are funded leaving much outstanding science unfunded), and a decreasing inflation-adjusted budget further exacerbates the problem of much outstanding research not being conducted.

Unfortunately, the poor funding will negatively impact US economic productivity and resilience. For example, understanding organismal physiology and ecosystems dynamics provides our food production systems from agricultural to marine aquaculture industries with information needed to maintain safety of the food systems and to respond to ecological changes such as those caused by droughts or flooding or the appearance of new diseases.

- IOS supports projects that address national priorities at a variety of levels, such as "supporting innovative early stage research" and supporting "foundational biological research" and "investments that develop tools and technologies with the potential to open new areas of discovery". (https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/memoranda/2017/m-17-30.pdf)
- We believe that the alignment of IOS activities with national priorities should be communicated more broadly and effectively.
- We recommend that IOS provide some indication of what level of support for national-priority-focused projects is expected or desired, in order to allow for an assessment of how well this this goal is being met.
- IOS should also evaluate ways to encourage grant submissions that relate to current and emerging BIO priorities, as well as to other NSF-wide and national priorities.
- The fundamental research and discovery supported by IOS is recognized as critical to the success of constituent groups (e.g., other Federal Agencies) whose focus is on applied and translational science. This contribution is a definite strength of IOS.
- Fundamental research is the engine of applied science. Without sacrificing the important role of IOS in advancing fundamental research, IOS should look for opportunities whereby its research outcomes may be linked to economic development through mechanisms such as SBIRs, i-Corps grants, creation of startup companies etc.

OTHER TOPICS

1. Please comment on any program areas in need of improvement or gaps (if any) within program areas.

Comparative biology is one area in which proposals may fall within gaps between existing IOS programs and/or between IOS and other BIO divisions. This is particularly acute in comparative genomics, but it is also a problem for research into organismal diversity in neural systems, and more generally in any discipline that has transitioned into a "mechanistic" phase. The COV recognizes that it is incumbent on applicants to articulate the implications of their work for understanding mechanisms, evolutionary processes, or other broader issues in biology. Nevertheless, it also recognizes that comparative biology, when done using modern methodological and analytic approaches, can be foundational in supporting new areas of interest to NSF, including the *Rules of Life*, as well as the ongoing interest within IOS of linking processes across levels of analysis. For example, the comparative analysis of neural systems was highlighted as a unique contribution of NSF to the BRAIN project in a 2013 Report "Discovering General Principles of Nervous System Organization by Comparing Brain Maps Across Species" when done with a well-considered combination of reference species and non-traditional, non-model organisms. Similarly, the 2016 NSF Workshop on Foundational and Translational Research Opportunities to Improve Plant Health emphasized the importance of increasing the species diversity of sequenced genomes and computational resources to provide important insights into the variation of genetic and genomic expression, as well as to identify candidate genes for resistance. We see the incipient fusion of new functional genomics tools with traditional comparative and macroevolutionary disciplines as both an exciting and inevitable development, but one that may not currently have an obvious "home" within current IOS/BIO Directorate structure. It is likely that similar issues arise for comparative studies in other disciplines within IOS where comparative studies with newly emerging tools could provide discoveries not possible by focusing on single species. We are encouraged that the new "no deadline" submission system may provide an opportunity to address this through increased flexibility in convening panels and collaboration across BIO divisions.

2. Please provide comments as appropriate on the program's performance in meeting program-specific goals and objectives that are not covered by the above questions.

None.

3. Please identify agency-wide issues that should be addressed by NSF to help improve the program's performance.

IOS occupies a unique position within the directorate and across the foundation, operating across scales from molecular networks, through organisms to ecosystems. This moment in the evolution of NSF and biological sciences presents opportunities to promote the division within the foundation. For example, IOS is naturally positioned to play a leadership role in advancing the '*Understanding the Rules of Life*' and '*Growing Research Convergence at NSF*'. The move to 'no deadline' submissions provides the program staff the opportunity to reorganize their collaborative processes as they rethink panel focus and composition. We recommend using this organizational moment of change to create a unified mission statement to use in communication within Bio and across the foundation. It should resonate well with the appropriate elements of the *Ten Big Ideas* and emphasize desired outcomes that will resonate with stakeholders within the community, the public

and Federal government. A consistent message coming from all IOS program staff and leadership is encouraged.

The funding rate for internally-reviewed proposals in our sample of IOS proposals was 80% (27/33). The high funding rate results from a PD pre-review that is done when PIs inquire about these internally-reviewed opportunities. PIs are only encouraged to apply if the PD(s) think the proposal is fundable. Including these internally-reviewed proposals inflates the apparent funding rate which is listed as 23% in the IOS Self Study, but the COV was informed that the funding rate for panel-reviewed proposals is under 10%. The 23% value is misleading and it would be better if it were not emphasized in public statements about the IOS funding rate. The misleading higher funding rate is a problem because it gives Chairs and Deans at a PI's home institutions an unrealistic view of how difficult it is to get funding from IOS, and this is particularly problematic for the career progress of junior researchers.

We understand that unlike previous COVs our charge did not include an assessment of research and educational outcomes of IOS-supported programs. Rather these outcomes are being analyzed at the Director's office. We applaud the Director's interest in assessing the impact of IOS and other NSF programs. However, we believe that access for the COV to outcomes data (or perhaps the results of the analysis of outcomes performed in the Director's office) would significantly improve the ability of the COV to make recommendations that would have the greatest impact on improving the work of IOS and its alignment with the broader mission of NSF.

4. Please provide comments on any other issues the COV feels are relevant.

The COV strongly suggests increasing the media presence for IOS. The COV believes it is important to increase the visibility of integrative organismal biology both within NSF more generally, and particularly for stakeholders, the general public, and policymakers. We recognize there are hurdles that must be overcome to develop a communication strategy for IOS, including constraints imposed by a centralized (but overextended) Office of Legislative and Public Affairs (including the Public and Communications Media staff). We also understand that IOS staff are already time limited, resources within the division are already strained, and that impactful science communication demands professional resources. Yet, we see need and, more importantly, enormous opportunities to grab the attention and imagination of the public while also showing the potential value of integrative organismal biology for a wide range of societal and economic impacts.

Going forward, we recommend that IOS can mitigate some of the obstacles to implementation by leveraging materials and resources already created by IOS grantees in research projects. In addition, the enormous growth of mass media technologies and venues will facilitate the Division's communications efforts, and greatly increases the potential reach and influence of the work supported by IOS. A few suggestions to broadcast the importance of IOS's sponsored research are:

-An IOS YouTube channel that makes IOS news more accessible and that distributes them more widely (this channel could include short clips already produced by NSFs Public Communications and Media and those produced in Broader Impacts in IOS funded projects).
-A compilation of TED talks by IOS funded researchers on IOS funded research.
-A compilation of TED ED lessons developed by IOS-funded PIs.
-Partnerships with Google Earth.

5. NSF would appreciate your comments on how to improve the COV review process, format and report template.

The COV appreciates the large amount of work that goes into the preparation for a COV meeting, and thought that the staff were extremely helpful in providing follow-up data when needed during the meeting. The COV suggests several changes to the process that would help both the COV members and the NSF staff conduct the COV evaluation more efficiently.

Process: (1) Review Schedule:

The COV felt that the time provided to review material prior to the meeting was not sufficient. Having access to the COV documents approximately a month prior to the meeting would allow sufficient time for a thorough analysis of the material. Similarly, having the instructional webinar earlier would be helpful. The COV understands that material will be updated as the meeting approaches.

Process: (2) Data Availability and Access:

The COV would appreciate being provided with data that is both more thorough and a better match to the questions being asked in the Template. It would be very helpful to generate a check list of data needed for each question asked to ensure that the relevant information is readily available to the COV. We do want to emphasize that the COV appreciated the effort of the NSF staff to gather that data at the meeting. IOS could also use the COV's requests to the staff as a guide to the types of data that would be helpful.

Specific suggestions include:

- The COV had a particularly difficult time analyzing true success rates of proposals at multiple points in the submission process, not just at the award stage, as well as comparing them along multiple dimensions. This made it difficult to assess application rates, success rates, funding levels, or other metrics for, for example, URMs, women, a diversity of institution types, or across geographic region and EPSCoRE status. We appreciate IOS's concern about not overloading the COV with data summaries, but an analysis of success rates is a particularly important component of the COV's charge, and full, transparent, and understandable data is crucial to this. We note that much, but not all, of these data are available and were provided to the COV during the meeting. We also realize that the data-reporting format is dictated NSF-wide. However, including more detailed success rate data in the COV materials and Self Study prior to the meeting to match the questions we are asked to address would have made the COV process more efficient. If there currently NSF wide standards for Self-Studies, we suggest that the Division argue for more flexibility in preparing these documents.
- The COV suggests providing all eJackets rather than a sample, as this would have supported a more accurate analysis of multiple items contained in the template.
- The COV would benefit by a more efficient method for accessing specific information from eJackets, such as whether or not they were flagged as "transformative" and any other information that is specifically queried in the Template. Additional columns in the downloadable eJacket excel file would help with this to ensure that there is an appropriate column for each question specifically asked of the COV.
- Use of information in individual jackets would be enhanced by being able to download, or at least view online, all documents included in the eJacket for a given application, as a single document, rather than having to select and open each component file separately. Related to this point, there seems to be a technical glitch in the system when more than one tab of a browser is opened, each containing a different eJacket file. When the user opens one eJacket in a new tab, and then a second eJacket in a second tab, clicking on any given document in the second eJacket yields the corresponding document for the first eJacket. This means that only one eJacket can be opened at a time, which is inefficient.
- Access to site visit documents should be provided, as this was an item the COV was specifically asked to comment on.

- Data descriptive of the period assessed by the COV was very thorough. The COV would benefit from access to previous metrics so that the change from previous periods can be assessed.

Template Format:

The COV felt that the overall organization of the Template was effective in guiding their deliberations. Having the Template in a free text Word format rather than table format would make the initial writing and merging of sections more efficient even if the final document is compiled into a table format.

Other: Charges to COVs:

The COV knows that the evaluation of process and mechanism by our COV is distinct from the evaluation of outcomes, and understands the rationale for dividing the IOS evaluations along these lines. However, it is difficult to evaluate the effectiveness of process without knowing the success of outcomes. The COV suggests that the outcome analysis be completed first, and the results communicated to the COV evaluating process and mechanism.

IOS Specific Questions

1. How might we ensure that new investigators as well as mid-career scientists are equipped with appropriate skills to participate in multidisciplinary, collaborative, and integrative research?

The COV suggests that one way to address this charge is to examine existing career enhancement programs and assess whether they have dimensions that could be enhanced and/or modified to address the goals of this charge. We also suggest some ideas that might require new programs that would be specifically designed to address the goals of this charge. Although we find most of the ideas proposed in this answer to be appealing, **it is important that a cost/benefit analysis be applied before these are implemented so that core programs are not adversely affected.**

Examples of existing programs that have the potential to enhance the development of skills in multidisciplinary, collaborative and integrative research within existing IOS programs include the undergraduate REU, graduate student NRT, postdoc PRFB (BIO-wide Postdoctoral Research Fellowships in Biology including NPGI-PRFB) and Career awards. Supplemental opportunity awards (ROA) can be used to promote faculty development in primarily undergraduate colleges. In addition, IOS has expertise specifically promoting early career and mid-career opportunities with the plant genome program early career awards (ECA) with encouragement of career mentors and mid-career awards (MCA) with co-PIs and senior personnel as mentors or to facilitate training in new area. Additionally, DEB has OPUS which targets synthesizing a body of related research projects over an extended period. It would be valuable to evaluate these programs to identify applicability of these type of mechanisms toward the promotion of collaborative research directorate wide.

Both the early-career faculty stages and the graduate and undergraduate student stages appear to be relatively well supported within IOS. For early-career faculty, IOS has continued to support this stage through the CAREER mechanism and with a success rate in funded proposals in this category similar to that experienced by the total pool of applications (although absolute funding levels in all areas are currently far too low due to budget constraints). We recommend that attention and support be continued for the early-career stage of faculty through normal funding channels with a note that funding at this stage supports the advancements of IOS disciplines into the future. The NSF graduate NRT programs as well as Graduate Research Fellowships could also be reviewed for ways to promote a culture of collaboration. We find that REU grants (both the broader REU program and REU supplements to IOS grants) have allowed undergraduates the opportunity to receive

collaborative experiences in order to help them enter disciplines in the IOS realm. These sorts of mechanisms lay a foundation for being part of a collaborative culture that trainees will carry with them for the rest of their career.

We note that IOS has had an increase in recent years in the numbers of grants co-reviewed with other directorates. We assessed the Jackets for about 15 awards that received joint reviews and noted that a consistent criticism in the panel summaries of those projects that were declined was that although the two PIs had complementary areas of expertise they were not coordinating their skills in a clear manner and the project was not well integrated. In the funded proposals, this integration was viewed to be exemplary. This observation highlights the importance of being intentional about collaborative training to promote modern collaborations.

We suggest that the post-doctoral stage be given more attention for the development of collaborative research experiences. Currently, PGRP has a post-doctoral program that includes a strong mentoring component and excellent networking opportunities for candidates receiving these awards. We suggest that funding be continued for this program and that successful models for training and supporting post-docs in PGRP be broadened to include all of IOS, with specific emphasis on multi-disciplinary training (e.g., support for post-docs to have inter-lab training opportunities).

Second, we recommend a joint early- and middle-career faculty time release/sabbatical program for development of collaborative science projects and/or for gaining skills in a new research approach or method that will enable inter-disciplinary projects. These could be modest one-semester supplements for a faculty member to cover salary and travel in order to advance their research program in new and innovative ways through the process of inter-disciplinary collaboration, and could have a focus on developing projects for the *Rules of Life* and other emerging programs. In addition (or instead), supplements to current grants could be made to support travel to other labs for faculty to develop research and educational collaborations and to learn new skills and this could be included as a new grant supplement mechanism along with other programs such as REU, RET, RAHSS, and ROA. Also, we think that the Research Coordination Network (RCNs) can provide a cost effective way to promote the development of a collaborative culture. This point is discussed in detail in the answer to Charge question 2 concerning how to integrate modern genomics more widely into IOS programs.

2. Functional genomic approaches that directly interrogate genome to phenome relationships will be key to enable progress on the Understanding the *Rules of Life* Big Idea: Predicting Phenotypes. How might the Division promote a balance between support for functional genomic technologies in research communities focused on emerging non-model systems (e.g. those supported by the EDGE program) and support for functional genomics research and tools in communities using well described model systems (e.g. Arabidopsis, fruit fly or model crop plants)?

During the period under review, genomics approaches continued to revolutionize our understanding of the genome to phenome relationship, especially broadly across the tree of life. As a focal point for organismal biology at NSF, IOS has a responsibility to support the study of a diversity of organisms at a variety of levels from molecules to ecosystems, and from genome to phenome. IOS has been a leader in supporting the development of diverse models that exemplify important biological principles across the tree of life. Examples are as diverse as hummingbirds as models for flight biomechanics and physiology of tomatoes as models to drive the directed development of new varieties with greater stress tolerance in the field and better flavors for consumers.

Integrative biology has benefited from rapid technological advances in diverse areas. These include analysis of 'parts lists' using genomics (DNA sequencing and whole genome assembly), transcriptome, proteome, and other 'omics analyses, combined with advances in functional genomics (e.g., CRISPR, transgenesis, and ex-vivo expression methods) in emerging models. Yet, IOS also supports research using classic model organisms such as Arabidopsis and Drosophila when they are the most appropriate systems for questions in integrative biology. **Thus, we suggest that the balance of support for traditional models vs. novel or emerging systems be determined by a combination of submissions from the community and evaluation of these submissions by panels within the context of the questions being addressed.**

The Enabling Discovery Through Genomics Tools (EDGE) program has the potential both to raise the profile of emerging model systems and provide cutting edge tools for their study. Integrative organismal biology includes understanding intermediary cascades at biochemical, cellular, and physiological levels that can provide important insights into how the relationship between the genome and phenome is influenced by the environment. We encourage IOS and NSF to keep the bidirectional nature of the relationship between the phenotype and genotype in mind when considering developing new opportunities and support for submitted projects. We emphasize that IOS has an important role to play in funding projects aimed at understanding intermediate mechanisms that may allow phenomes to feedback and affect genomes. The genome to phenome initiative and the *Rules of Life* more broadly provide an extraordinary opportunity to raise awareness and appreciation for the critical role of integrative mechanistic insight in developing broadly applicable explanations for both unity and diversity across biological systems.

IOS has used multiple cost effective ways to advance research using non-model organisms. RCNs, workshops, Early-Concept Grants for Exploratory Research (EAGER) grants, and conference grants can promote grass-roots development of communities focused on emerging models, as well as making functional genomic tools more accessible. We are particularly supportive of opportunities that decrease time lags in adoption of cutting edge technologies by non-specialists. This problem can be especially acute at institutions that are less research intensive or among investigators that are already well established in a particular area. Research Coordination Networks (RCNs) have been a cost effective way to provide cross training in cutting edge technologies using symposia, short and focused courses, and travel grants to trainees and PIs to cross train in expert labs. Increased visibility and funding of Research Opportunity Awards (ROAs) can be especially effective in allowing Primarily Undergraduate Institution (PUI) investigators to involve themselves and their students in studies of new model taxa and technologies. We encourage support for flexible grant supplements to mid-career researchers to lower the barrier to functional genomics in the integrative biology community.

3. Following assessment of the preliminary proposal process and an early transition to no deadline submission by PGRP, the remainder of IOS is in the first year of a transition to a new proposal submission process involving no deadlines. What considerations and/or data tracking should we prioritize as we move forward?

We recommend that IOS collect and analyze data on the factors below as the division transitions to no-deadline submissions and compare them to data from the pre-proposal period.

- Number of submissions both per fiscal year and per quarter;
- Success rate both by fiscal year and as a function of quarter of submission;
- Time from submission to decision as compared to previous review paradigms, and as a function of submission quarter
- Collaborative nature of proposals i) within IOS, ii) across BIO, and ii) across Directorates;

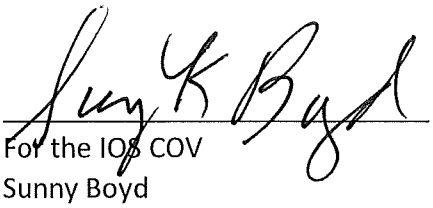
- PI and CoPI characteristics: individual demographic characteristics, particularly those indicative of underrepresented status, years since degree, new investigator, prior support as well as prior submissions that were not funded.
- For the reasons explained at the end of question #IV.9, **we do not recommend that a category called "race" be included uncritically in tracking PI success through the new no-deadline system. However, we do recommend that the NSF track ethnicity, socioeconomic status, and other identity elements that contribute to the reality of racism, across the individuals that participate in and enact the mission of the NSF**. For more specific discussion of this issue and the rationale underlying this recommendation, please see the end of the answer to question #IV.9.
- Institution type, including EPSCoR institutions, as a function of both submissions and awards.

We also recommend that IOS monitor and address any unintended impact on the following areas:

- Proposal quality (based on panelist and ad hoc ratings as well as Program Director (PD impressions);
- Participation by prospective PIs;
- Challenges to administrative efficiency;
- Appearance that reductions in proposal submissions could be seen as lack of activity in area;
- Timing of awards (under the scenario that NSF continues to operate under continuing resolutions);
- Size of awards
- Panel breadth. The no-deadline model is likely to result in smaller panels due to the possibility of fewer proposals per year coupled to more panels per year. It will be important to monitor panel expertise and to ensure sufficiently broad expertise.

Finally, the COV was enthusiastic that the no-deadline approach could facilitate sharing of portfolios among BIO and other directorate PDs. The data on jointly funded projects by year should be tracked and be provided to the next COV.

SIGNATURE BLOCK:



For the IOS COV
Sunny Boyd
Chair

Integrative Organismal Systems
Committee of Visitors Meeting
Signature Block
June 8, 2018

Richard Amasino
University of Wisconsin

Carole LaBonne
Northwestern University

Gregory Ball
University of Maryland

Robert Last
Michigan State University

Sunny Boyd
University of Notre Dame

Lynn "Marty" Martin
University of South Florida

Elizabeth Brainerd
Brown University/Friday Harbor Laboratory

Carlos Martinez del Rio
University of Wyoming

Erika Edwards
Yale University

James Moroney
Louisiana State University

Cassandra Extavour
Harvard University

Nipam Patel
University of California, Berkeley

Anne Fennell
South Dakota State University

Scott Poethig
University of Pennsylvania

Susan Gregurick, BIO AC Liaison
NIH/NIGMS

Zuleyma Tang-Martinez
University of Missouri-Saint Louis

Michael Grusak
USDA/ARS Fargo

Nathan Urban
University of Pittsburgh

Daniel Hahn
University of Florida

Joy Ward
University of Kansas

Gretchen Hofmann
University of California, Santa Barbara

Walt Wilczynski
Georgia State University

Ellen Ketterson
Indiana University

Friday, June 8, 2018

As the designated Advisory Committee Representative to BIO/IOS 2018 Committee of Visitors, I hereby submit the attached Fiscal Year 2018 COV Report to the Directorate for Biological Sciences Office of the Assistant Director.

Susan L Gregurick

Susan Gregurick
Advisory Committee Representative

June 8, 2018

Date