

**FY 2009 REPORT TEMPLATE FOR
NSF COMMITTEES OF VISITORS (COVs)**

The table below should be completed by program staff.

Date of COV: September 2-4, 2009
Program/Cluster/Section: Advancing Theory in Biology, Ecology of Infectious Diseases, Microbial Genome Sequencing
Division: Emerging Frontiers
Directorate: Biological Sciences
Number of actions reviewed: 123
Awards: 59 total; ATB: 13; EID: 22; MGS: 24
Declinations: 64 total; ATB: 13; EID: 27; MGS: 24
Other: 0
Total number of actions within Program/Cluster/Division during period under review:
Awards: ATB: 15; EID: 23; MGS: 45 (Does not include supplements or CGIs)
Declinations: ATB: 115; EID: 265; MGS: 194
Other: ATB: 0; EID: 50 MGS: 39 (Includes supplement awards, Return without reviews, Withdrawal, Other, but not CGIs)
Manner in which reviewed actions were selected:
<p>For the Self Study, only proposals submitted to ATB, EID and MGS were used to report data in tables indicated to be "from jacket sample." Data indicated as "from EIS" reflect all EF activities, not just the three that are the focus of this CoV. The jacket sample contains 123 jackets. A random numbers generator was used to select jackets in each activity (ATB, EID and MGS) to achieve roughly a 15% sample of all of the proposals received in each activity, stratified across 2006-2008. The sample in each activity was adjusted to approximately half awards and half declines, and to include at least 10 award jackets per activity. The jacket sample contains representative declines and awards from all panels and all relevant proposal solicitations, such that it will provide examples of all styles and specifics of program and panel activities in these three years. Of the 123 jackets in this sample, 2 awards are SGERs, 1 is a conference award and one is a workshop award, all of which are non-competitive awards reviewed internally by NSF program directors. These jackets were not included in the analyses in the Self Study, but we invite the panel to examine these jackets nonetheless. Second, we identified 2 declined proposals that had only 2 of the required 3 reviews. These declined proposals are included in one analysis table of the Self Study (under Question A.1.5), where we report 2 jackets with incomplete documentation in FY 2007. No other analyses were performed on these jackets. Therefore, most of the analyses in this Self Study were performed on a sample of 117 jackets. Lastly, a total of 6 award jackets in the sample will not be accessible by the panel owing to panel-wide conflicts of interest. These 6 award jackets were analyzed, however, and so the data reported in the Self Study are based in part on these conflicted jackets. No information or data reported in the Self Study can be attributed directly to the conflicted jackets. The complete listing of sample jackets, except for those with panel-wide conflicts of interest, is available on the eJacket CoV module. In addition, the CoV module contains a complete listing of all proposals in these three activities in 2006-2008. The CoV can request to see any proposal on this list during the meeting.</p>

OVERVIEW

The COV is impressed by the quality of the projects undertaken during the past three years in EF. The portfolios of MGS, EID, and ATB are diverse and broad, and the research is of high quality. EF has clearly served its role in these three years as an incubator of new ideas and as the force behind the development of new communities of researchers. The Biology Directorate staff is clearly committed to ensuring the success of these programs and to managing them with excellence.

The COV does have some recommendations that are crucial for sustaining the successes of EF into the future. EF is characterized as an incubator of new and exciting ideas at the frontiers of science, and the successes within the division are a testament to the value of this mission. The COV also recognizes that the long-term success of EF is a function of more than just the quality of a program's incubation during its residence in EF. Most importantly, the success of EF depends on the topics the EF staff chooses to fund, and the fates of those programs as their funding in EF ends. The COV suggests that EF should focus on these two areas in the coming years.

Generating ideas. The COV commends EF on the diversity of community workshops during which ideas are shared across the Directorate. The Leading Edge workshops each year are a good example, and all of the currently funded programs were considered outstanding topical areas by the COV. The COV suggests that EF should make more clear when and how the use of external expertise is used to explore fully the nature of and the potential for funding the emerging frontiers in biology. The COV felt that EF should consider increasing the use of such expertise.

Transitioning ideas. The COV strongly recommends that the staff of EF focus on the fates of programs as they transition from being funded by EF. The fates of these programs are currently diverse. For example, the MGS program is being integrated into the core programs across the Directorate, while the EID program is being moved into the Division of Environmental Biology in a manner still to be determined. If EF is to succeed as an incubator of new ideas, it should pay even closer attention to ensuring successful transitions. To this end, the COV offers the following general recommendations.

- Develop an explicit transition plan for each program.
- Develop metrics for the success of programs that transition after residence in EF.
- Publish lessons learned at the frontiers as programs complete their tenure in EF. The greatest impact would be as reviews in *Science* or *Nature*, or as articles in the national media.
- The 2012 COV should meet with the senior management team, including Division Directors, at the start and at the end of their deliberations to discuss program transitions out of EF.
- The 2012 COV should also receive materials that characterize the fates of the current programs after their transition from EF.

The last page of this report includes these and contains a more extensive list and summary of specific recommendations.

PART A. 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, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question. Discuss areas of concern in the space provided.

<p>QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS</p>	<p>YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE¹</p>
<p>1. Are the review methods (for example, panel, ad hoc, site visits) appropriate?</p> <p>Comments:</p> <p>ATB: Only panel reviewers were used in the first year of the ATB program. The use of external and panel reviewers in the second year was a significant and important improvement.</p> <p>EID: Yes</p> <p>MGS: Overall, the methods of review appear to be appropriate.</p>	<p>Yes</p>
<p>2. Are both merit review criteria addressed</p> <p>a) In individual reviews?</p> <p>b) In panel summaries?</p> <p>c) In Program Officer review analyses?</p> <p>Comments:</p> <p>ATB: Both merit review criteria were addressed in individual reviews, in panel summaries, and in the review analyses. We noted that the intellectual merit was described in more detail in all three cases, and that more emphasis should perhaps be placed on the broader impacts criterion.</p> <p>EID: Virtually all proposals submitted to EF contained both Intellectual Merit and Broader Impacts statements. Almost all reviews mention both aspects.</p>	<p>Yes/No</p>

¹ If "Not Applicable" please explain why in the "Comments" section.

<p>The Intellectual Merit criterion is addressed fairly well in all reviews, but the quality of the individual reviews varies with regard to Broader Impacts. The panel summaries generally deal effectively with both aspects, as do the Review Analyses.</p> <p>MGS: The CoV is also not sure how effective the feedback mechanism is to PIs, as it seems to vary significantly among proposals. Ideally, a PI should be able to use the summary statements from a failed proposal for a resubmission, but the effectiveness and clarity of this feedback is invariably not clear.</p> <p>Although the following issues apply variably to all three programs, they were especially noted for MGS. The CoV has observed what appears to be a trend to give more weight to the intellectual merit versus broader impacts of proposals, and thus question whether criterion two is getting the emphasis that it deserves. This is apparent throughout the individual reviews, panel summaries and PO review analysis.</p> <p>While individual reviewers consistently provide sufficient information in their reviews, this does not always translate into an equally informative summary statement. In particular, the summaries do not always provide sufficient information for the PI, and the documentation for recommendations is often incomplete (from the perspective of the materials available to the CoV).</p>	
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<p>3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals?</p> <p>Comments:</p> <p>ATB: In the first year, several reviews were not very informative (too short, too vague). This was perhaps because the reviewers sometimes did not have the appropriate background needed to judge the proposal.</p> <p>In the second year, the merit reviews were detailed and informative. Similar critiques were frequently mentioned by multiple reviewers, providing consistent feedback to the investigators. This is especially important for declined proposals. Reviewers also frequently identified the same strengths in submitted proposals.</p> <p>EID: The majority of reviewers do provide substantive comments.</p> <p>MGS: Note however that panel summaries and the number of reviews received for each proposal is quite variable in the sample of proposals available to the CoV. Thus, are different proposals reviewed equally? Also note in particular that information on how panel rankings transition to the final scoring is not always clear. Finally, Broader Impacts does not get the level of assessment that the Science invariably does even though both are to be weighted equally.</p>	<p>Yes/No</p>
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<p>4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)?</p> <p>Comments:</p> <p>ATB: Panel summaries effectively described major concerns and highlights addressed by the reviewers, especially in the second year of the program. It was rare to see a proposal with reviewer ratings that spanned fair to excellent. Most funded proposals had very good to excellent ratings, and most unfunded proposals had fair to good ratings. The proposals that were high priority versus low priority were easily divided into two groups by the panel, with the vast majority of high priority proposals funded.</p> <p>EID: Yes.</p> <p>MGS: In general, the panel summaries do not reflect the range of evaluations captured in the reviewer summaries. Thus there is a lack of overall consistency across the proposals available to the CoV.</p> <p>For example, a Highly Competitive proposal scored 1 x F and 4 x V, while a proposal declined scored 1 x E, 1 x G, 1 x F, and 2 x V. From the materials available to the CoV, it is not possible to discern how these decisions were reached from any of the provided documents and perspectives, including the review analysis; presumably these subtleties are reflected in the panel discussions or happened subsequent to the deliberations, but are not captured in extant documents available.</p>	<p>Yes/No</p>
<p>5. Does the documentation in the jacket provide the rationale for the award/decline decision?</p> <p>(Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.)</p> <p>Comments:</p> <p>ATB: Yes</p> <p>EID: Yes.</p> <p>MGS: Necessary information is missing, and indeed is not in the Analysis Report; thus the overall basis of some decisions is not clear (see also # 4 above).</p>	<p>Yes/No</p>

<p>6. Does the documentation to PI provide the rationale for the award/decline decision?</p> <p>(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 or telephoned with diary note in jacket) of the basis for a declination.)</p> <p>Comments:</p> <p>ATB: see above comments</p> <p>EID: As always, PIs of proposals that are declined greatly benefit from panel summaries that are extremely clear. Of particular value are summaries that clearly encourage or discourage resubmission. In the case of the latter, clear and specific recommendations for modifications are extremely helpful.</p> <p>Science Assistants who preview and edit panel summaries before they are submitted by the panelists can make an enormous difference in the quality of the summaries. We encourage NSF to train and reward Science Assistants to encourage their excellence.</p> <p>MGS: Overall, it is not clear that the panel summaries give PIs feedback that reflects well the individual reviews.</p>	<p>Yes/No</p>
<p>7. Is the time to decision appropriate?</p> <p>Note: Time to Decision --NSF Annual Performance Goal: For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals.</p> <p>Comments:</p> <p>ATB: For the 2007 submission, 90% of the investigators were notified within four months and the remaining investigators were notified within six to eight months. For the 2008 submission, the earliest notification was four months after receipt of the proposal. All investigators in 2008 were notified within seven months. More than 80% of the investigators were notified within the six month goal.</p> <p>EID: In all years except 2008, dwell time was less than six months for >80% of proposals. In 2008, this number dropped to 57% with 14% dwelling for 9-12 months and 2% for more than a year. The rapid increase in average dwell time</p>	<p>Yes</p>

<p>suggests an anomalous circumstance.</p> <p>MGS: Given the workload and internal processes required at NSF, certainly within reason. However, from the applicant’s perspective, the timeframe seems to be lengthy. A shorter time frame would be unreasonable.</p>	
<p>8. Additional comments on the quality and effectiveness of the program's use of merit review process:</p> <p>ATB: : Review of the ATB program improved significantly from the first to the second year of the program. This improvement likely arose from a good choice of reviewers and a clearer program description. This trajectory is commendable.</p> <p>EID: The EID panel appears to have developed an exemplary review process through their selection of panelists and through the careful oversight and cooperation of the program officers.</p> <p>MGS: The CoV would benefit from a better understanding of the true process and extent to which panel discussions are captured in available documentation in proposal jackets, especially for those proposals whose aggregate scores versus funding decisions are not clear (cf. comments in # 4 and 5 above).</p>	

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE ²
<p>1. Did the program make use of reviewers having appropriate expertise and/or qualifications?</p> <p>Comments:</p> <p>ATB: In the first round, a number of reviewers commented that they did not have the expertise to review the proposal. In these cases, the panel discussion reached consensus. In the second round, the background of the reviewers was more consistently well-matched with the subject of the proposal. This resulted in reviews that were more interpretable by the investigator and that were more consistent with one another.</p> <p>EID: The range of reviewers is very good. The different reviews for each proposal complemented each other well and together provided a very good critical view of the strengths and weaknesses of the project. Most proposals</p>	<p>Yes</p>

² If “Not Applicable” please explain why in the “Comments” section.

<p>received five reviews, which complement each other and together provide a full evaluation of the strengths and weaknesses of the proposal. Although there is much variation in opinion, the multiple reviews together almost always lead to a clear view of the quality of the proposed work.</p> <p>MGS: The range of reviewers and host institutions was broad, and it is clear that the requisite expertise has been engaged. However one wonders if the Broader Impacts component could have been better addressed if community members with expertise in education and outreach had been included in the panels. This is particularly concerning as both Intellectual Merit and Broader Impacts are supposed to carry the same weight in the review process.</p>	
<p>2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups?</p> <p>Note: Demographic data is self reported, with only about 25% of reviewers reporting this information.</p> <p>Comments:</p> <p>ATB: The data across the entire Emerging Frontiers program in the Self Study indicate that the reviewers are balanced. In the ATB program, the reviewers were weighted heavily towards major research institutions. Little or no representation from undergraduate institutions may limit the emphasis on broader impacts; we therefore feel like an effort should be made to more effectively balance institutional type.</p> <p>EID: Yes</p> <p>MGS: Yes, a balance in each of the above categories seemed to be achieved, to an extent likely possible, across the range of proposals funded and declined. However, participation by underrepresented groups is still a problem.</p>	<p>Yes/No</p>
<p>3. Did the program recognize and resolve conflicts of interest when appropriate?</p> <p>Comments:</p> <p>ATB: Conflicts were recognized. We identified only one conflict wherein a researcher submitted a review on a grant for which he/she had submitted a supporting letter. That conflict was resolved appropriately.</p>	<p>Yes</p>
<p>4. Additional comments on reviewer selection:</p> <p>ATB: This program made good progress in moving from the first to the second year. External reviewers, as well as panel reviewers, were used in the second year and reviewers with more appropriate expertise seemed to have been selected.</p>	

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

<p style="text-align: center;">RESULTING PORTFOLIO OF AWARDS</p>	<p style="text-align: center;">APPROPRIATE, NOT APPROPRIATE³, OR DATA NOT AVAILABLE</p>
<p>1. Overall quality of the research and/or education projects supported by the program.</p> <p>Comments:</p> <p>ATB: The quality of the funded research is top-notch, with the funded projects clearly demonstrating that new biological theory can be developed that crosses levels of biological organization. The focus on education and broader impacts was limited.</p> <p>EID: Yes</p> <p>MGS: On aggregate, the technological breadth of the proposals was in the range of excellent and very good, although some individual proposals are weak on the educational component (i.e., criterion 2).</p>	<p style="text-align: center;">Appropriate/~</p> <p style="text-align: center;">Yes/No</p>
<p>2. Does the program portfolio promote the integration of research and education?</p> <p>Comments:</p> <p>ATB: The majority of proposals that were funded had broader impacts that included training of graduate students and post-docs. In that way, the program portfolio does successfully integrate research and education. Beyond inclusion of graduate students and post-docs, though, broader impacts were quite limited. Involvement of undergraduate students or groups from undergraduate-only institutions was very limited. We note that broader impacts aimed at course development or other types of training opportunities was virtually non-existent.</p> <p>EID: Yes</p> <p>MGS: There has clearly been significant impact on training of the next generation of scientists. However, integration of research and education is missing or rarely apparent.</p>	<p style="text-align: center;">Yes/No</p>

³ If “Not Appropriate” please explain why in the “Comments” section.

<p>3. Are awards appropriate in size and duration for the scope of the projects?</p> <p>Comments:</p> <p>ATB: 3 year proposals, with an average funding size of \$340,000 are ideal for ATB. We would recommend increasing the size of the award, but not the duration, to some extent, if it were to be used to fund education- and broader-impact related goals.</p> <p>EID: Yes</p> <p>MGS: Budgets are appropriate for the field, for despite the declining costs of sequencing per se, costs for trained annotators and bioinformatics specialists are generally high.</p>	<p>Yes</p>
<p>4. Does the program portfolio have an appropriate balance of:</p> <ul style="list-style-type: none"> • Innovative/potentially transformative projects? <p>Comments:</p> <p>ATB: The program portfolio is skewed towards the potentially transformative, because the proposals that were funded have the potential to change the way we think about similarities in processes and in patterns across levels of biological organization. Yet, each funded project had a concrete empirical application of the proposed theory, thereby allowing for innovative progress in a specific subfield. The current balance between innovative and transformative projects, we think, is appropriate for a program like ATB.</p> <p>EID: Yes</p> <p>MGS: Yes with respect to choice of organism, environmental niche, novel pathogens, etc. No with respect to technology development per se.</p>	<p>Yes/No</p>
<p>5. Does the program portfolio have an appropriate balance of:</p> <ul style="list-style-type: none"> • Inter- and Multi- disciplinary projects? <p>Comments:</p> <p>ATB: Perhaps more so than other programs, many of the investigators of funded proposals have been trained in areas outside of biology, and many of the collaborations involve not only biologists but also physicists, computer scientists, and mathematicians. That said, we found there to be a definitive emphasis on funding theory that is strongly relevant to advancing biological understanding. Proposals that were too abstract or not applied to any specific empirical system did not get funded.</p>	<p>Yes/No</p>

<p>EID: By design, one of the great strengths of the EID program is to bring together multi- and interdisciplinary teams of investigators. The program has achieved this goal and it is one of the great strengths of the EID funding mechanism.</p> <p>MGS: No, especially given exclusion by program definition of functional genomics (as we were informed by program staff).</p>	
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<p>6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program?</p> <p>Comments:</p> <p>ATB: Most funded proposals were single investigator proposals, which is appropriate for this theoretical biology program. Two out of the 14 proposals were collaborative research projects, which we feel is a good representation.</p> <p>EID: See above. The emphasis on multi-investigator projects is appropriate for the program</p> <p>MGS: Most awards are of the single investigator category, as opposed to program projects.</p>	<p>Yes</p>
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<p>7. Does the program portfolio have an appropriate balance of:</p> <ul style="list-style-type: none"> • Awards to new investigators? <p>NOTE: A new investigator is an investigator who has not been a PI on a previously funded NSF grant.</p> <p>Comments:</p> <p>ATB: Over the two years of data available to us, three new investigators and ten previously funded investigators were awarded grants. Over two years, this is a good balance. We were slightly concerned, however, that none of the awards made in the second year were made to new investigators. Emphasis should be made to have new investigators represented in coming years, especially those new investigators who are at the beginning stages of their careers.</p> <p>EID: The award rate for new investigators was similar to the award rate for all investigators from 2006-2008. In 2007, the award rate for new investigators (11%) exceeded the award rate for all investigators (9%).</p>	<p>Yes</p>
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<p>MGS: Yes is the impression from the selection of proposals provided, but overall statistics were not provided.</p>	
<p>8. Does the program portfolio have an appropriate balance of:</p> <ul style="list-style-type: none"> • Geographical distribution of Principal Investigators? <p>Comments:</p> <p>ATB: Of the thirteen ATB proposals awarded, nine different states were represented, which is a good distribution. However, five awards were made to schools in California, with two awards going to one school.</p> <p>EID:</p> <p>MGS: Yes, from the selection of proposals provided.</p>	<p>Yes</p>
<p>9. Does the program portfolio have an appropriate balance of:</p> <ul style="list-style-type: none"> • Institutional types? <p>Comments:</p> <p>ATB: The portfolio is weighted towards large research universities, with some representation from the Cal State system and CUNY. There is no representation from undergraduate-only institutions. (But we note that such institutions were significantly under-represented in the applicant pool.) Proposals from these schools should be encouraged.</p> <p>EID:</p> <p>MGS: In particular, four- year and historically under represented institutions have limited participation in the selection of proposals provided.</p>	<p>Yes/No</p>
<p>10. Does the program portfolio have an appropriate balance:</p> <ul style="list-style-type: none"> • Across disciplines and sub disciplines of the activity? <p>Comments:</p> <p>ATB: The portfolio was heavy on the ecological and evolutionary theory applications; though theory is possibly more advanced in this field of biology. More emphasis could be placed on theory that has a direct application to the cellular or molecular level.</p> <p>EID: In EID, one of the strengths of the program is the integration of teams investigators from different disciplines.</p>	<p>Yes</p>

<p>MGS: It is striking that functional genomics is excluded from the program.</p>	
<p>11. Does the program portfolio have appropriate participation of underrepresented groups?</p> <p>Comments:</p> <p>ATB: Three of thirteen proposals involve women and three of thirteen proposals involve underrepresented or minority groups, which seems reasonable.</p> <p>EID:</p> <p>MGS: See, for example, # 9 above.</p>	<p>Yes/No</p>
<p>12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports.</p> <p>Comments:</p> <p>ATB: Appropriate</p> <p>EID: The EID program is particularly responsive to the call for transformative research emphasized in the National Science Board document of May 2007. In the NSB document: “Transformative research is defined as research driven by ideas that have the potential to change radically our understanding of an important existing scientific or engineering concept or leading to the creation of a new paradigm or field of science or engineering. Such research is also characterized by its challenge to current understanding or its pathway to new frontiers.” The EID program transformed the way in which disease transmission is studied by encouraging different disciplines, such as epidemiology, ecology, public health, hydrology, and geology to join their very different expertise and outlook in common projects. No other federal funding mechanism provides this type of transformative opportunity within the strategically critical area of infectious disease research.</p> <p>MGS: Yes, clearly, and the future of the program is an issue and of significant concern in the broader community.</p>	<p>Yes</p>
<p>13. Additional comments on the quality of the projects or the balance of the portfolio:</p> <p>MGS: Overall, an excellent pool of applicants, awardees, and reviewers; however, experience in broader impacts (criterion two) appeared to be not as strong.</p>	

A.4 Management of the program under review. Please comment on:

1. Management of the program.

Comments:

ATB: The program officers communicate well among themselves and have a keen sense of the current status of the field and future needs. This program activity is relatively new and the program officers are enthusiastic about the direction and progress. They clearly want this program to continue to provide the time for the field to develop and mature.

The program management seems appropriate. Having directors from several divisions is important, especially given ATB's program description focusing on developing theory that crosses multiple levels of biological organization.

EID: The cross-directorate partnership appears weakened by funding imbalance and uncertainty. There is some evidence of inadequate communication among program officers.

However, the EID panels and different perspectives of the chosen reviewers were excellent. Management effectively evaluated panel reviews and provided clear reasons for funding decisions. Most summary statements to rejected proposals clearly stated the reasons for rejection. It is our impression that the progress of the portfolio of projects was managed well, although we received few supporting data or analyses demonstrating the overall success of the funded projects.

The continued oversight by the same program officer over many years has probably helped the program in terms of panel quality, consistency of mission, and development of a strong research community focused on this topic. Multi-investigator teams are often complex to evaluate during the proposal stage, and complex to manage through the funded phase. We can clearly see the thorough review process. The funded phase and outcomes are harder for us to evaluate in a comprehensive way from the limited information available to us. However, from our knowledge of the program and cases we have been able to examine, we believe EID is an outstanding program with regard to accomplishment. Much of that success arises from the cultivation of the research community with regard to obtaining high quality proposals. The continuity of the program and the steady management contributes to that success.

MGS: Evidence of conflicting views between program officers reveals weak support for the program. The basis for funding decisions is not always clear. This is a highly successful activity that needs a clear leadership into the next step to develop annotation accuracy. Program is not providing that direction nor advocating other than sun-setting the program in favor of individual investigator awards.

MGS has clearly reviewed and funded highly meritorious programs. However, there seems to be a striking lack of appreciation for the impact and overall value of the program, which spans most of a decade. In particular, we observe no concept of the need for, broader impact, or future directions and evolution of a program where technological progress has been so striking. Thus, there is clearly a need for an independent, critical assessment of the program and its potential.

2. Responsiveness of the program to emerging research and education opportunities.

Comments:

ATB: The program has funded some of the most exciting, emerging topics in ecology and evolutionary biology.

EID: The EID program has been tremendously successful in responding to a key, emerging research need: the integrative understanding of infectious disease transmission and the processes that alter ecological relations that may lead to changes in epidemiology. The program is also making a strong effort to expand the range of approaches, for example, to incorporate expertise from social sciences with regard to how human activities and social processes feed into systems of disease transmission. Such activities would be particularly timely in response to various pandemic planning issues that have arisen in response to potential avian and swine flu pandemics.

MGS: Excellent with respect to technical aspects, although educational components are often weaker than technical ones.

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

Comments:

ATB:

EID: Based on our evaluation from the listing of funded proposals, the EID program is already a mature program that does a very good job of developing an appropriate portfolio. The COV did not receive any specific information about criteria that guided the development of the portfolio.

MGS: There are clearly major weaknesses in this program as relates to the planning and prioritization process, especially in later years, and it is clear that no path forward is contemplated or identified.

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

Comments:

ATB: ATB is a new program, so there were no previous COV comments/recommendations.

EID: The EID program was not reviewed by the previous COV.

MGS: Previous CoV reports were not particularly informative with respect to MGS. The intent to sunset this program makes this a somewhat moot point.

5. Additional comments on program management:

MGS: The CoV considers it especially critical that NSF seek independent, critical review and assessment of this program (e.g., NSB, NRC).

PART B. RESULTS OF NSF INVESTMENTS

The NSF mission is to:

- promote the progress of science;
- advance national health, prosperity, and welfare; and
- secure the national defense.

To fulfill this mission, NSF has identified four strategic outcome goals: Discovery, Learning, Research Infrastructure, and Stewardship. The COV should look carefully at and comment on (1) noteworthy achievements based on NSF awards; (2) ways in which funded projects have collectively affected progress toward NSF's mission and strategic outcome goals; and (3) expectations for future performance based on the current set of awards.

NSF investments produce results that appear over time. Consequently, the COV review may include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made.

To assist the COV, NSF staff will provide award "highlights" as well as information about the program and its award portfolio as it relates to the three outcome goals of Discovery, Learning, and Research Infrastructure. The COV is not asked to review accomplishments under Stewardship, as that goal is represented by several annual performance goals and measures that are monitored by internal working groups that report to NSF senior management.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 OUTCOME GOAL for Discovery: *"Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering."*

Comments:

ATB: ATB is a new program, with first funding in late-2007/2008. Only two rounds of proposals have been funded. Outcomes are therefore not exceptionally clear yet. We read through the annual reports of the funded proposals to identify several research "highlights". Several examples are presented here.

Principal Investigator: Brian Enquist

Award ID: 0742800

Institution: University of Arizona

Proposal: Combining Theories For Plant Architecture, Allometry, and Traits to Develop the Next Generation of Scaling Theory

The goal of this project is to work towards effectively linking existing theories of plant architecture, anatomy, and physiology into a broader theoretical framework. This framework would scale from plant tissues to individuals, populations, and communities by concentrating on plant water flux and carbon. Core assumptions of previous individual theories will be addressed and the biological realism of these theories will be increased. This project has supported the PI in publishing two papers in PNAS.

Principal Investigator: Edmunds, Peter J.

Award ID: 0742567

Institution: The University Corporation, Northridge

Proposal: Homeostasis, stoichiometry and dynamic energy budgets at multiple levels of biological organization.

The PI proposed to expand the use of dynamic energy budgets to relate physiological and biochemical processes to organismal performance and to population and ecosystem phenomena. In addition to innovative modeling based on flux balance analysis, the investigator will use evolutionary dynamics to explore the extent to which the maximization principles underlying flux balance analysis are reasonable in an evolutionary context.

EID: The EID program has been very successful in advancing the frontier of knowledge in the transmission of infectious disease—a topic of great significance for society, and also of great importance for understanding basic biological processes. To give one example, a team at the University of Michigan found that immunity of individuals who do not become severely ill provides the key to predicting and controlling cholera outbreaks. Incorporating these low pathogenic infections into the dynamics of infection and disease, the research suggests an improved schedule of vaccine administration. The research team, which included expertise in statistics, epidemiology, public health, and ecology, developed new statistical methods to develop this understanding.

MGS: MGS has clearly served this role successfully with regard to the technical aspects of the program, and the U. S. is recognized as a leader in microbial genomics. Note, however, that the

integration with the educational components (criterion two) is viewed as less successful.

B.2 OUTCOME GOAL for Learning: “Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.”

Comments:

ATB: ATB is a new program, with first funding in late-2007/2008. Only two rounds of proposals have been funded. Outcomes are therefore not exceptionally clear yet. We read through the annual reports of the funded proposals to identify several research “highlights”. Several examples are presented here.

Principal Investigator: Brian Enquist

Award ID: 0742800

Institution: University of Arizona

Proposal: Combining Theories For Plant Architecture, Allometry, and Traits to Develop the Next Generation of Scaling Theory

The investigator was prominently featured in a recent PBS NOVA special on use of fractal geometry. This film represents a prominent outreach activity. The NOVA film covered several of the main goals associated with this NSF proposal. Dr. Enquist invested significant time in 2008 to be interviewed and filmed. The special 'Hunting the Hidden Dimension' was shown on PBS late October 2008 featured allometric scaling and metabolic scaling theory. The program can be accessed here <http://www.pbs.org/wgbh/nova/fractals/>.

Principal Investigator: Desharnais, Robert A.

Award ID: 0827595

Institution: Cal State LA Univ Aux Serv

Proposal: Dynamics of Layering in Biological Systems

A component of the current project is the organization and hosting of two working symposia on the “Dynamics of Layered Biological Systems.” The goal of these symposia is to bring together experts on a wide variety of biological systems to educate one-another on their particular research areas, to discuss similarities and differences in their systems and approaches to modeling them, and to share ideas on how they could collaborate from this cross-fertilization. The PIs are in the planning stages of the first symposium which is scheduled for 15-16 January 2010 in Pasadena, California. Three distinguished scientists have agreed to be keynote speakers: (1) Prof. James A. Glazier, Director of the Biocomplexity Institute at Indiana University, an expert in the modeling of multicellular systems, (2) Prof. Yannis G. Kevrekidis, Pomeroy and Betty Perry Smith Professor of Engineering at Princeton University who is an expert in complex multi-scale systems modeling and computation and inventor of the equation-free modeling approach, and (3) Dr. Johan van de Koppel, a researcher at the Centre for Estuarine and Marine Ecology of the Netherlands Institute of Ecology and leader of a project for testing for spatial self-organization in mussel beds. Speaking invitations are being extended to experts in the modeling of various layered biological systems as well as their students and postdocs.

Principal Investigator: Alonzo, Suzanne H.

Award ID: 0827504

Institution: Yale University

Proposal: From Individual Interactions to Evolutionary and Ecological Dynamics

Alonzo has included some of this research (modeling methods generally applicable within evolution and ecology) in a graduate course on quantitative methods taught in Spring 2009.

Principal Investigator: Lynch, Michael R.
Award ID: 0827411
Institution: Indiana University
Proposal: The Evolution of Gene and Genome Architecture

The investigator hosted a visiting mathematics undergraduate student from St. Louis University. This student was supported by an NSF REU grant to Indiana University.

Principal Investigator: Edmunds, Peter J.
Award ID: 0742567
Institution: The University Corporation, Northridge
Proposal: Homeostasis, stoichiometry and dynamic energy budgets at multiple levels of biological organization.

This project is enhancing research and training coordination between a research I university and a primarily teaching institution with an M.S. program that serves a large number of Hispanics.

EID: The EID program contributes to workforce development in two ways. First, by creating novel interdisciplinary research groups, established scientists are broadening their understanding of science, which helps in both research and in teaching. Second, the EID grants frequently include graduate students and postdocs, who get broad training within the context of the research programs. Some projects go further, for example Joseph Eisenberg's study of "Antibiotic resistance and human health," which has important broader impacts in both research and education. On the research side, that project focuses on "Intensive antibiotic usage in animal husbandry is a major contributor to the growing problem of antibiotic resistance worldwide, posing threats to both animal and human health. We seek to understand the role that ecological, social and behavioral processes play in the spread of antibiotic resistance in human populations." On the educational side, the project hired staff from the study region in rural Ecuador and is providing them with training in field data collection, disease surveillance, and epidemiology. The project will also offer training and periodic health education workshops for Ecuadorean community health workers, and will hire and train masters-level students in health, ecology, and other fields at the Universidad San Francisco de Quito.

MGS: With respect to literacy, the impact is considered to be quite high (e.g., press releases, publications for lay audience, and education).

Awardee institutions are clearly world class, thereby providing educational and training opportunities broadly (however, criteria one and two are not equally represented), and overall workforce development has realized a very positive impact. However, the lack of adequate inclusion of underrepresented minorities continues to remain a problem that has escaped solution.

B.3 OUTCOME GOAL for Research Infrastructure: “*Build the nation’s research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.*”

Comments:

ATB: ATB is a new program, with first funding in late-2007/2008. Only two rounds of proposals have been funded. Outcomes are therefore not exceptionally clear yet. We read through the annual reports of the funded proposals to identify several research “highlights”. Several examples are presented here.

Principal Investigator: Lynch, Michael R.
Award ID: 0827411
Institution: Indiana University
Proposal: The Evolution of Gene and Genome Architecture

Several maximum likelihood methods were developed as part of this project. These should soon be of broad use to the population-genomics community. To help ensure their practical utility, the PI is working with Bernhard Haubold, Max Planck Institute, on the development and practical implementation of these maximum likelihood methods at no cost to the project.

EID: EID does not explicitly develop infrastructure. The primary achievement is in expanding the horizons of both students and established scientists, with regard to their access to different expertise and perspectives.

MGS: With respect to research infrastructure, bioinformatics resources (e.g., the Comprehensive Microbial Resource) received significant emphasis in the early years, but declined in later years. Technical infrastructure per se was not an emphasis (e.g., no emphasis on sustaining community resources such as microarrays). We note here a contrast with, e.g., the NSF Plant Genome Research Program, which has placed significant programmatic emphasis on both developing community resources and criterion two.

PART C. OTHER TOPICS

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

The “virtual division” of Emerging Frontiers was established at NSF in 2003. Its mission has evolved in the past six years. For the period under review, the mission included serving as a hub for projects that are high-risk but with potentially high intellectual payoff, conceptually cross-cutting, in need of management by EF, or time-limited. The new mission statement, defined in 2009, focuses on two key areas: the establishment of term-limited funding opportunities that are in need of targeted investment, and the development and implementation of innovative forms of peer review. This revised mission statement is considerably more in line with the name “emerging frontiers” than the previous mission statement, and the COV generally supports the direction of the changes in the mission statement. The COV recognizes that the goals of EF, more than those of other divisions in the agency, need to be flexible and responsive to changes in the agency as well as in the scientific community. That said, the COV encourages the Division to cultivate a stable mission for EF.

The COV recognizes that the virtual division was created for practical as well as intellectual reasons and thus that its portfolio needs to be flexible. Nevertheless, the COV encourages EF to remain focused on this redefined mission and to take care not to serve as a catch-all for programs that don't easily fit. In this regard, the COV agrees with and commends the recent decision to move the Centers to the Division of Biological Infrastructure.

The COV also feels that the current Mission Statement (7/13/09) does not fully capture the mission of EF. In particular, the COV feels that the purpose of elevating alternative forms of merit review to the core mission is not well-articulated in the current Mission Statement. Based on conversation with the Assistant Director, the COV understands the purpose, but feels that it could be better characterized in the Mission Statement. In addition, the Mission Statement does not currently capture some of the elements of the EF portfolio, including the inclusion of NEON, which was also well-articulated by the Assistant Director.

One important area for continued consideration by EF is the process by which new program areas are developed and, critically, ended. There is clearly enthusiastic recognition by program officers across the agency of the potential of EF as an incubator of new ideas and new communities. The many and varied successes of the MGS, EID, and ATB programs, as well as earlier efforts, are a testament to this. Developing a portfolio of programs for EF that are truly at the frontier requires a tremendous breadth of vision. **The COV strongly recommends that EF develop a regular, delineated advisory mechanism to identify research priorities that includes participants from the broader external community.**

The process by which the fate of these programs is determined after their incubation is more problematic. EF currently considers a range of possible fates for programs. These include moving their administration to other divisions but maintaining their budgets and topical focus, and eliminating their budgets and special focus and allowing their intellectual focus to be integrated with that of the core programs. Clearly, the ultimate success of EF is dependent just as much on its success in transitioning programs **from** EF as in incubating them in the first place. The new mission statement itself illustrates the tension between the initiation and continuation of programs within EF, as it says only that EF will “establish” new programs, but not that it will focus on their fate after incubation. One example of how to increase the probability of a successful transition of a new area from EF to other divisions is to ensure that program officers with the appropriate disciplinary expertise are in place during the transition. For example, with the end of the MGS program and the return of its key questions to the core programs, the agency should be sure that program officers with the appropriate microbial expertise are in place. **The COV recommends that the overall process by which programs are transitioned from EF, as well the decisions for particular programs, be given the highest priority during the next three-year period.**

ATB: Advancing Theory in Biology, as described, supports the development of new theory or the significant extension of existing theory to explain phenomena that occur independently at two or more levels of biological organization. In the first year of the program, there were several proposals that were declined, in part because reviewers did not consider mathematical models or simulations to necessarily be theory. We think a brief description of exactly what theory is and what it isn't would be useful to investigators who plan to submit proposals.

MGS: There is clearly a need for an independent, unbiased, critical review of the program and its future trajectory, which should examine the role of NSF in overall national priorities in the areas of microbial genomics and metagenomics, and thus an appropriate future role for NSF in these critically important areas.

In addition, the broader impacts (criterion two) needs attention from the perspective of program review and stewardship.

C.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.

MGS: The MGS program has filled a unique niche in support for microbial genomics, but the CoV is not convinced that the potential of the program has been achieved, and that a future trajectory has been fully considered (see also # 1 above).

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

MGS: The program needs to be completely rethought and rebooted, including the issues associated with genome sequencing versus functional genomics, technology development, genome annotation, focus emphasis un-culturable organisms, data release, community resources, etc.

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

ATB: We feel that there is a crucial need to formalize the decision-making process for the origination of new EF programs and for their discontinuation or movement to more permanent funding in the core.

EID: The COV finds the EID program to be exemplary in many respects. The projects funded are of high quality and are demonstrably in line with NSF's mission statement. The COV program is concerned about the fate of this program, given its notable successes. Through cooperation with NIH and other divisions within NSF, the EID program has become a model of inter- and intra-agency cooperation and also of the potential of multidisciplinary science. Indeed, the multidisciplinary nature of projects in EID is their hallmark and makes the necessity of maintaining EID as a special competition, whether housed in EF or elsewhere, clear. The EID program serves as a model for how EF can cultivate an intellectual community in an area of public importance, thus achieving intellectual and practical breakthroughs to issues of societal concern.

One concern of the COV is that the budget for the EID program has remained constant while the costs associated with proposals in it have increased, resulting in the granting of fewer awards. The COV recommends that EF and/or NSF seriously consider how to increase the budget for EID. One obvious possibility is to increase NSF's contribution, and the COV supports this possibility. An additional approach is to encourage the participation of more agencies involved in the study of infectious diseases. The EPA and the CDC are two possibilities, both of which have shown increasing interest in the ecology of infectious diseases.

MGS: A major issue is an appropriate home and scope for a program such as MGD within NSF, given budget requirements, rapid evolution of underlying technologies, program redefinition required, review process, program stewardship, etc.

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

The current set of information is abundantly adequate to support the role and function of the COV. The report template is about right in capturing the headings for important considerations. The agenda was set with sufficient flexibility to enable the COV to modify scheduled activities as necessary. The electronic availability of program jackets greatly simplifies and facilitates the review process. However, some significant data gaps in project jackets limited the COV from formulating adequate responses to numerous template questions.

Information supplied prior to the meeting

The materials provided to the COV were well-organized and easily accessible via the internet. The self study was well-prepared and included a thorough analysis of trends and outcomes. Some data could have been more usefully presented. For example, the COV was interested in outcomes for MGS, EID, and ATB separately, as well as together, though only the combined data were available. The COV was interested in considering funding rates for women, minority, and new investigators. These data were presented, but not in the most useful form. For example, the self study presented the percentage of successful proposals by women, but not the percentage of submitted proposals by women. This omission made it difficult for the COV to determine the significance of observed patterns. **The COV recommends that future self-studies include a breakdown of outcomes by major program as well as the inclusion of useful metrics for comparison (e.g. rates of success compared to rates of submission).**

It also would have been useful to have summaries of the numbers of publications from past awards for longer-running programs like EID and MGS. These data are available in principle through the project reports in the jackets, but getting at them is a tedious process.

It was hard to analyze outcomes over a full portfolio, because the only summaries were in the individual annual project reports. One helpful addition would be a listing of publications associated with each funded grant, summarized on in a single document. Although that information is in the annual progress reports, it is too tedious to click through on each grant to obtain that information. Similarly, it was not easy to see the relation between the broader impacts proposed by the portfolio of projects and what was actually accomplished.

Information supplied during the meeting

The COV found the presentation by the Division Director at the opening of the meeting to be extremely helpful, providing the history and the context for the development and growth of EF. The staff was helpful, flexible, and responsive to the needs of the COV. The program officers presented useful summaries of the programs and were responsive to questions from the COV.

The preparation of the report during the COV meeting was technically challenging. The staff is to be commended for rapidly setting up a wiki site and providing memory sticks to ease collaboration.

SUMMARY OF SPECIFIC RECOMMENDATIONS

- Increase use of external sources to explore increased funding for emerging frontiers in biology.
- Develop an explicit transition plan for each of the programs leaving EF.
- Develop metrics for the success of programs that transition into core after residence in EF.
- Consider the production of comprehensive syntheses that capture lessons learned at the frontiers as programs complete their tenure in EF.
- Set up 2012 COV to meet with the senior management team at the start and end of the COV to discuss program transitions out of EF.
- Provide for 2012 COV materials that track the fates of programs after transition from EF.
- Consider the appropriate balance between permanent and rotating program officers, especially for programs administered through or transitioned from EF.
- The COV is concerned about the workload of program officers. Program officers need to have time to think broadly and to continue active engagement in science.
- Continue to stress the importance of Broader Impacts in the evaluation of proposals, both for reviewers and for panelists. One suggestion is to add panelists with education expertise.
- As an incubator, experiment with training postdoctoral fellows and graduate students to increase diversity and improve quality. ATB may be a good test ground for such an initiative.
- As an incubator, partner with HRD to develop and promote inclusive workforce training models.
- Review Analyses should clarify the basis for funding recommendations, especially for proposals with mixed ratings on panel and external reviews.
- Continue to refine the EF Mission Statement to capture the full range of its portfolio.
- Train and reward Science Assistants to preview and edit panel summaries before they are submitted by the panelists to improve the quality of the summaries.
- Future self-studies should include a breakdown of outcomes by major program as well as the inclusion of useful metrics for comparison (e.g. rates of success and rates of submission).
- The structure and process for the current COV is to review a traditional set of programs. Owing to transient programs and the EF residence in the office of the Assistant Director, the structure of and information provided to future COVs should be given careful consideration.

SIGNATURE BLOCK:

For the Emerging Frontiers Committee of Visitors
Julius H. Jackson
Chair