<u>Note</u>: *Edits were made by the National Science Foundation to remove specific mention of center names and declinations.*

DBI CoV: 13-15 September 2016

Executive Summary

The CoV sincerely appreciates the dedicated efforts of the administrative, professional, and scientific staff of DBI in facilitating activities of the committee. The materials assembled for the CoV's perusal were <u>critical</u> to our effective and efficient consideration of the full charge to the committee. In particular, the thoughtful responses of DBI to the report from the 2013 CoV, the depth and breadth of strategic analyses in the "Self Study Document," and the provisioning of the "Golden Data Set," as well as other documents and reports, enhanced our ability to review broadly and deeply, and devote considerable attention to emerging and higher level issues and themes. In addition, we were grateful for the open and collegial discussions with administrators, program officers, and professional staff in DBI, as well as with program officers in the three other divisions of BIO (DEB, IOS, and MCB).

Although much of the CoV's efforts were focused on activities from FY-13 to FY-15, we did so within the context of the present activities in the Division, and with a vision toward strategically informing the future. Our perspective during the assessment was built on the premise that DBI, as the "infrastructure" division of BIO, should complement and liberate the integrated research and educational activities of the other three Directorates, and should fully serve the broad and diverse community of scholars by enhancing the integration of research and education in all of the sub-disciplines of biology.

The CoV was quite impressed with the accomplishments of DBI during the assessment period, and based on the preponderance of evidence, arrived at a number of overarching conclusions:

- DBI is efficient and effective in supporting all facets of the biological sciences with regard to research resources.
- DBI is efficient and effective in supporting all facets of the biological sciences with regard to human resources development and engagement.
- Although a number of concerns remain, DBI has substantively improved its performance in managing Centers and high-dollar investments, and shows promising signs of continuing to improve in that regard.
- With few exceptions, the quality and effectiveness of the review process, the selection of reviewers, the management of programs, and the resultant balance in the portfolio are very good to excellent, and appear to be improving.
- The organization of clusters and programs within DBI, and DBI's integration with other divisions of BIO, appear to reflect an effective structure for efficiently and effectively supporting the infrastructural, research, synthesis, and human-resources mission of BIO.

- Leadership, in addition to management, within DBI has improved significantly since the previous CoV, and based on our discussions with NSF personnel is much appreciated by staff and program officers within DBI, as well as by those in DEB, IOS, and MCB.

Clearly, the CoV considers the trajectory of DBI in fulfilling its mission to be very good.

In the spirit of improving and enhancing the effectiveness and efficiency of DBI, we highlight a number of broad issues early in our report (see Overarching Comments section). Particular details are explored for the Human Resources Cluster, the Research Resources Cluster, and the Centers Cluster in the separate sections that adhere to the requested content and format of the Report Template. We strongly recommend that the division devote considerable effort to address these concerns from both strategic and tactical perspectives.

Overarching Comments

The management and leadership trajectory of DBI is quite promising. Moreover, the constituent clusters and programs are operating to good effect to protect the quality and integrity of program operations so as to enhance the ability of NSF to attain its mission and strategic objectives. Nonetheless, a number of emergent themes of concern have arisen in our reviews of the three clusters and were at least touched upon in our conversations with Division and Directorate personnel. Many of these themes of concern are detailed in the separate sections that correspond to division clusters. For ease of exposition, we communicate these emergent themes of concern via a series of bullets.

- Although the structure and organization of DBI appears to be effective, communication should be improved within DBI, between DBI and the other Divisions of BIO, and between DBI and the BIO Front Office. This is particularly important as the infrastructural and human resources functions of the Division need to integrate seamlessly with the research thrusts of the other divisions to attain maximal impact for the Directorate. This requires constant multi-way communication, and should involve stakeholders (i.e., the community of biological scientists and educators who do or should avail themselves of NSF's programs) before critical decisions are made about the nature or timing of major programmatic activities. DBI in particular, and perhaps BIO in general, should regularly revisit this challenge, so as to identify hurdles to effective and timely communication, and devise tactics and strategies to overcome them.
- In partnership with the BIO Front Office, DBI should institutionalize mechanisms to enhance "transparency of decision-making" and establish data-driven processes to guide administrative decisions (e.g., origin and decommissioning of a Center or Program, including decisions regarding "hiatus-status," or decisions regarding folding a DBI program into an NSF-wide or other programs).
- Strategic portfolio planning should be undertaken regularly for all programs to determine the allocation of resources to innovation vs. development vs. sustainability projects, as well as to assess the success of these investments in attaining Division and Directorate goals. Indeed, assessment of the impacts of investment in infrastructure is perhaps one of the most challenging tasks faced by DBI. Assessment information can be derived from various levels of data collection, ranging from PI-specific annual reports, to BIO-wide community-

specific data that assesses the value of DBI infrastructure in the greater context of biological research. Arguably, the impact of DBI on the larger community is the bottom line. However, the development of infrastructure often starts with individual projects. Perhaps analyzing the connections and relationships between PI-specific data and community-based data can lead the way to identify addressable gaps in the portfolio that can maximize the impact and value of the DBI investments.

- Strategic planning is encapsulated in the budget. Nonetheless, it is unclear how budgetary allocation and strategic planning interface in DBI, or in BIO with regard to DBI. We strongly recommend much more transparency in and engagement during processes in which strategic planning is implemented via budget planning activities.

- To reduce risk and enhance efficiency, DBI should continue to emphasize program and project management training, especially for POs associated with large investments. Project management training should ideally be conducted in the context of scientific projects rather than the context of commercial projects (e.g., real estate).

- DBI in particular, but all Divisions in BIO in general, should devise mechanisms and processes to leverage the expertise and experience in the HR Cluster to better catalyze efforts to broaden participation in Centers and other large investment projects. Importantly, broader impacts in general and broadening participation in particular should be as much a criterion for the decision to fund and renew large projects and Centers as it is for decision-making for more modest investments.

- DBI in particular, and BIO in general, should explore innovative and entrepreneurial approaches to incentivize participation in panels by individuals associated with minority and minority-serving institutions, 4-year colleges, and community colleges. In addition to broadening perspectives on integrated research and education, this could serve as a mechanism to increase submission of proposals from these types of institutions or to increase collaboration between investigators from different categories of institutions.

- Although improving, panel summaries still focus much more broadly and deeply on issues related to scientific merit than on those related to broader impacts. DBI's use of webinars to enhance panelist awareness of the need to <u>substantively</u> address <u>both</u> criteria represents a viable mechanism for doing so. Instructions to reviewers about what to look for in the broader impacts section of proposals (e.g. pro-active as opposed to passive statements) may also be conveyed via webinars preceding review panels. Nonetheless, this must be coupled with vigilant oversight by POs during panels so that summaries substantively reflect both criteria and that investigators receive accurate feedback about the decisions to fund or decline a proposal.

- "Panel-recommended but program-declined" proposals represent a point of tension between NSF and the community it serves. This is particularly true when the rationale for the decision, or the adjudication of positive and negative factors involved in the process of decision making, are not communicated or communicated effectively to the investigators. DBI should be commended for addressing such issues effectively in the official Program Review and associated documents in e-jacket. Nonetheless, the rationale contained in the Program Review is not always communicated effectively to investigators (we understand that the content or tone of the Program Review may not be appropriate to send, *verbatim*,

to investigators). This issue is of particular concern for post-doctoral programs as well as for first-time or young investigators in all programs, who may not have sufficient familiarity with the proposal-review process to seek insight from cognizant program officers. Given the relatively low success rates at NSF and the increasing emphasis at colleges and universities on obtaining grants for tenure and promotion, this is a sensitive point in career development where NSF can make a positive difference and where addressing the "leaky pipeline" syndrome becomes even more critical.

FY 2016 REPORT TEMPLATE FOR
NSF COMMITTEES OF VISITORS (CoVs)

Date of CoV: September 13th – 15th, 2016	
Program/Cluster/Section: Research Resources, Human Resources and Centers	
Division: Division of Biological Infrastructure (DBI)	
Directorate: Directorate for Biological Sciences (BIO)	

Number of Actions Reviewed: 268

Awards: 108

Declinations: 160

Other: 0

Total Number of Actions Within Division During Period Under Review: 3291

Awards: 1076

Declinations: 2058

Other: 157 (e.g., Returned without review, Withdrawn)

Manner in Which Reviewed Actions Were Selected:

For both Human Resources and Research Resources clusters, one hundred jackets were randomly selected from each cluster for analysis. For the Centers cluster, all of the 37 actions were included in the sample. The complete list of proposals from which samples were taken was obtained from the NSF Enterprise Data Warehouse (EDW), the official storehouse of NSF proposal information. Using EDW, all of the DBI actions (awards, declines, and others; Table 6) with a DD-Concur date during the CoV period of review were identified, resulting in a list of 3306 actions. Administrative actions (n=15) pertaining to IPA/Rotator pay and the DBI FY 2013 retreat were removed from the set, resulting in a final total of 3291 actions.

To create the CoV document sample set for this CoV (Table 7), each action was assigned a randomly generated value in Excel, then the list of actions was sorted for FY, Program, and Random Value. One hundred jackets were then chosen to proportionally represent each program, as detailed in Table 6. Actions with the lowest random number in each program were selected to provide unbiased representation. Since the number of Center proposals was low, all of them were included in the list for a total of 268 items (this includes collaborative projects with more than one proposal). The resulting randomly selected samples and all Centers are available for review by accessing the CoV module C161977 in eJacket.

Additional data on each action managed by DBI during the CoV period was gathered from the EDW, resulting in approximately 1 million data points for CoV consideration. The data were consolidated into a "Golden Data Set" and used for all subsequent analyses included in this

report. A copy of this data set, including a pivot table to facilitate additional analysis and inspection by CoV members is included in the CoV document module. Data on Reviewers and PI demographics were also collected from the EDW, as described below. Copies of the data spreadsheets are included in the CoV document set.

CoV MEMBERSHIP

	Name	Affiliation
CoV Chair:	Michael Willig	University of Connecticut
CoV Members:	Susan Perkins	American Museum of Natural History
	Henry (Hank) Bart	Tulane University
	Elizabeth (Liz) Losos	Organization of Tropical Studies
	Suzy Renn	Reed College
	Nada Boustany	Rutgers University
	Nancy Wilkins-Diehr	UCSD Super Computing Center
	Daniel Howard	University of New Hampshire
	Jessica Faupel-Badger	National Institutes of Health
	Elizabeth (Toby) Kellogg	Danforth Plant Science Center and BIO Advisory Committee Representative

Human Resources Cluster

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(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? REU: suggest adding ad hoc or virtual reviewers to increase representation of key stakeholders in this program, particularly community college, PUI and MSI institutions, especially for those proposals that involve these institutions or groups as collaborators or key groups of recruits (which are most). Pre-funding site visits do not generally occur, but might be useful for deciding on proposals where there are questions regarding facilities or management. PRFP: Review methods seem appropriate for these proposals. RCN: Review methods are appropriate for these proposals. **Data Source: EIS/Type of Review Module**	Yes for all 3 programs

2. Are both merit review criteria addressed	
a) In individual reviews?	a) Yes for all 3 programs

b) In panel summaries? **c) In Program Officer review analyses?** REU: These proposals are somewhat unusual in the sense that broader impacts criteria are typically heavily discussed in all aspects of the merit review process. In fact, for some proposals, reviewers in particular struggled to meaningfully address the intellectual merit components when the theme of the site was broad. Overall, the reviews, panel summaries and review analyses were thorough in covering both of the major categories. PRFP: The tendency is to focus on the intellectual merit for these proposals, however virtually all addressed both criteria. Detailed feedback to PRFB applicants when Broader Impacts are deemed weak would likely support the NSF goal of addressing this critical merit review criterion. RCN: No issues. **Data Source: Jackets**	b) Yes for all 3 programs c) Yes for REU and RCN; often yes for PRFB

3. Do the individual reviewers giving written reviews provide substantive comments to explain their assessment of the proposals? REU: Reviews were thorough almost to a letter. Panelists seem to have been consistently well prepared and gave substantive feedback. PRFP: Individual reviewers generally gave detailed and substantive reviews for all proposals. Continued reviewer training and focus on substantive feedback on Broader Impacts merit criteria will reduce the exceptions noted in the CoV review. RCN: Individual reviews were fine. **Data Source: Jackets**	Yes for all 3 programs

4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? REUs: Panel summaries in most all cases provided sufficient detail regarding the proposal review and substantiated the recommendation of the panel. In rare cases, highly rated proposals had brief panel summaries that resulted from the general enthusiasm of the panel for the project. Panelists should be	Yes for REU, and RCN; mostly yes for PRFB

encouraged to more consistently convey the specific rationale for the comments that emerge in the panel summaries, should the recommendation be to award or decline. In declined proposals, detailed critique points should be identified explicitly.

PRFP: A few panels (Fall 2013, 2015) seemed to consistently suffer from inappropriately brief panel summaries that provided few details on the ranking of the proposal. A few proposals were rated highly meritorious but were not funded, and the rationale for the decline were not clear in the Review Analysis. The CoV notes that this is especially troubling given that the audience consists of new investigators for which detailed and transparent feedback is most critical in their career development and which may represent their first interactions with NSF. We encourage the program to ensure that these documents are as thorough as possible and transparently convey the synthetic decision on behalf of the panel with respect to their ranking. In the case of proposals submitted under the Broadening Participation strand, it is imperative that the panel and PO elaborate on how the proposal or PI are likely to have measureable impacts in this critical area.

RCN: No issues were noted in the small sample set examined (5).

Data Source: Jackets

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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.]

REU and RCN: Jackets were complete with documentation related to the award rationale. No particular issues noted.

PRFP: The CoV observed a small set of awards where substantial criticisms on the part of reviewers were treated with only brief or cursory mention by the PO in the review analysis. This was the case in the few instances where proposals with medium to low meritorious rankings were awarded. Better documentation of the basis for these decisions is recommended.

Data Source: Jackets

Yes for REU and RNC; mostly yes for PRFB

| 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.]

Communication to PIs applying to the REU and RCN programs were very thorough and informative in the case of both awards and declines.

In the case of PRFP, there was a small number of proposals where the panel summaries were brief and relied primarily on the individual reviews themselves. As mentioned above, this applicant demographic is most likely to lack experience in decoding the rationale of the panel's decision and may not wholly understand the process or the role of each of the documents. The PO should ensure that the documents provided to the applicant are easily interpretable with respect to the program awarding decision.

Data Source: Jackets | Yes for REU and RNC; mostly yes for PRFB |

7. Additional comments on the quality and effectiveness of the program's use of merit review process:	
None.	

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?	

Expertise and qualifications of reviewers is appropriate given the current distribution of awards in the HR cluster, however, if there is interest in reaching larger populations of students, such as for REU recruitment, there should be an effort to reach possible reviewers from community colleges, other PUIs, and MSIs. The 2016 Self Study specifies that: "*REU Site proposals ... require reviewers with experience managing cohorts of undergraduate students typically experiencing their first research experience in the biological sciences… What is necessary is a panel of experts in the area of implementing coordinated research experiences for undergraduates.*" Faculty from these institutions can contribute useful expertise to address this unique STEM training challenge, and the CoV encourages the program to reach out to this under-utilized reviewer pool. **Data Source: Jackets**	Yes for all three programs

2. Did the program recognize and resolve conflicts of interest when appropriate? No systemic issues were observed in any HRC program. In one instance during PRFB proposal review, a potential coi was addressed before the proposal was discussed.. This highlights the issue brought up on the 2013 CoV with respect to explicitly identifying the proposed PRFB mentor along with the institution in the proposal review materials provided to the panelists, and in the jackets provided to the CoV. This information was not readily available to the 2016 CoV without reading the full PRFB proposal. **Data Source: Jackets**	Yes for all three programs

3. Additional comments on reviewer selection: Actively recruiting reviewers and panelists from a more diverse cross-section of the biological community is highly recommended. There are solid examples of panels across all three programs of HRC where this is done effectively, particularly in the REU program and especially with respect to HBCU participation. The CoV noted little to no involvement from TCUs or CCs however. It is apparent that DBI and HRC leadership continues to value and invest in programs such as the REU and PRFP that are particularly focused on attracting and training scientists from under-represented groups, and recognize the "leaky pipeline" phenomenon that results in the loss of this human capital from the academy and broader STEM community. DBI could play an even more important role in broadening participation in and furthering career development for faculty at community colleges, MSIs, and	

PUIs by including them more extensively in NSF review service, perhaps by approaching the unique challenge of participation (high teaching loads and lack of administrative support) through a more entrepreneurial approach. These approaches might include expanding the use of ad hoc reviews solicited from these communities, and offering virtual participation opportunities integrated into an otherwise onsite panel. Developing financial incentives for the panelists' institution along with the standard NSF reimbursement to the panelist might also promote expanded participation. Broadening Participation remains one of the 'Grand Challenges' for the BIO Directorate, and DBI should continue to and expand its use of innovative strategies to address this problem. Identifying and engaging with URM leaders from within the Biological Science community to develop and deploy these strategies should be a priority.

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. The REU program appears well-managed. The POs confer on panel recommendations to bring an added level of consistency to the review of these proposals. The POs also expect all sites to participate in the URSSA survey so there is a measure of student outcomes embedded in all programs. POs are encouraging use of the URSSA-instrument among the REU supplements and other settings as a best practice for evaluation. This evaluation instrument should be promoted as a best practice across the other programs within HRC, and across the division and directorate. Overall, the PRFB is also well-managed although there are some programmatic decisions that seem unclear. The 2016 self-study mentions eliminating the year that could be requested by fellows for teaching training. The rationale or decision making process that led to the elimination of this training opportunity is unclear. The Deputy Division Director presented data on the professional trajectory of PRFB awardees that support the positive impacts of the program, especially fellows awarded within the Broadening Participation strand. Given the vexing issue of URM participation in BIO, especially among certain demographic groups at the faculty line level, the CoV expressed strong support for continued prioritization of the strand. Selection of PRFB disciplinary topic areas is addressed in the question below. The RCN program appears well-managed. More extensive evaluation of program impacts could highlight best practices, scalable network strategies, and potential pitfalls.

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

As was noted in the 2013 CoV, the PRFB program is responsive to identifying new areas for program strands but the process for selecting new focus areas was not transparent and the timeliness of communicating could be improved.

It does not appear that REUs emphasize specific target areas, so areas evolve as the community identifies them, which the CoV viewed as a program strength. One potential opportunity to investigate is the leveraging of technology to connect REU participants in small programs or isolated geographic regions to expand REU cohorts in an online learning community.

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

The CoV relied on the 2016 Self-Study document to understand the HRC program planning and prioritization process that guides portfolio development; some of the general ideas that guide portfolio development were also discussed in CoV sessions with POs and DBI division leadership. In general, the framework for developing diverse portfolios are sound and well-reasoned, and the implementation of these strategies appears to effect the outcomes observed in the portfolios across the REU, RCN, and PRFB programs.

Among the REU applications, there were examples of multiple applications coming from one institution, albeit focused on different scientific areas. It is unclear how multiple applications from the same site are viewed by the REU POs especially when, aside from the science focus being different, the REU programs may be very similar and draw on the same institutional recruitment infrastructure and local target audiences. Given that there remains some geographic regions and disciplinary areas underrepresented in the REU portfolio, the CoV would like to see a better rationale for the decision to make awards to the same institution that result in temporally overlapping REU programs.

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

In the 2013 CoV report, the committee made the following recommendation with respect to broader impacts. *We recommend that DBI lead the development of a Directorate-wide process to assess the effectiveness and impact of the "broader impacts" criterion, with attention to how the community has responded to changes in the guideline language for this criterion. In particular, we think it is important to know how well projects broaden participation and integrate research and education*. It is not clear how/if the program has

been responsive to this charge, nor what the results of this assessment was if it has been addressed. As such, the same recommendation is made in this 2016 report.

The 2013 CoV recommend that DBI lead the development of Directorate-wide strategies to increase the effective integration of biology research and undergraduate education. The 19 RCN-UBE awards support the committee's recommendation.

It was noted in the previous CoV report that mentors were not identified in the PRFB. This problem persists. This is exact language from the 2013 CoV report, as the access to mentor information in the PRFB jackets was still not readily available to the 2016 CoV, and would have aided in the thorough evaluation of the program.

In the 2013 CoV, the committee noted that "In some cases the lack of under-represented minority panelists or panelists from MSI/HBCU institutions was evident." The 2016 CoV saw evidence of increased participation on review panels from HBCU faculty, but other MSIs (especially TCUs) were poorly represented. Bridging this demographic gap should remain a focused goal of the program.

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

A. *Balance across disciplines and sub-disciplines of activity*

REU: A review of the awards during the CoV period shows an excellent balance across awards that would be considered to serve each of the three other Biology divisions' communities. It was also noted that several of the site awards showed innovative cross-disciplinary scopes and intersectional programs, which was seen as a positive. The effort of management to maintain these balances was clear.

PRFP: For the postdoctoral fellowship tracks that spanned subdisciplines within biology, such as the minority track and the intersection of math and biology track, there appeared to be an overall balance of awards, though these are more challenging to track because their titles are uniform and thus difficult to accurately classify. The CoV notes that the implementation of the Collections Research track in 2015, partly in response to the prioritization of biological collections and an attempt to incentivize young investigators to use the digitization resources catalyzed by iDigBio and the ABDC awards, may have the tendency to tip the balance toward awards in ecology and evolutionary biology (including systematics), but the Committee also noted several innovative and intersectional uses of collections in these proposals.

RCN: the RCN-UBE program only had five awards in the sample, and thus this was a challenge to ascertain. One award was to a professional society, which could represent a significant impact and reach if appropriate programs are developed.

B. *Balance of award size and duration*

The human resource programs are extremely consistent with respect to their sizes and durations and these seem appropriate for their scopes. We do not recommend any substantial changes.

C. *Balance of awards to new and early-career investigators*

The PRFB is funding beginning investigators in most all cases, as would be expected.

For the REU sites, there are very few new investigators (9%) awarded. The reason for this outcome may be related to the number of proposal submitted, or explicitly due to the quality of proposals from new investigators, but the program should consider strategies to increase participation for this community demographic.

RCN awarded ~10% of the small number of awards to beginning investigators. Reaching out to this demographic to increase the number of proposals should be a priority of the program.

DBI leadership mentioned the success of a former solicitation designed specifically to support new investigators (RIG), and highlighted the success of the program that was not fully understood until after its discontinuation. This insight was presented in the context of a timely formative program evaluation, but given the low participation of new investigators in some areas of DBI and HRC, especially among URM faculty, reinstating some form of research initiation grant would seem a good investment and is supported by the CoV.

D. *Balance of geographical distribution awards*

~26% of the REU awards, ~21% of PRFB awards and ~32% of the RCN awards went to investigators in EPSCoR states. Considering that that these states now make up over half of the potential applicant pool, DBI needs to continue efforts to increase representation from these regions within the portfolio of HRC programs.

E. *Balance of awards to different types of institutions*

Based on the pivot tables, 80 of the 215 awarded REU sites are at doctoral degree granting institutions or medical schools. Another 117 of the 215 awarded REU sites in the CoV period do not have a Carnegie Classification identified in the golden data set. It is unclear why data are missing for so many programs, and this hampered the CoV from addressing this question with much accuracy. Notably, there were only a few REU sites at 4-year institutions during the review period, only two at TCUs, and none at community colleges. While the rationale for this seems to arise from concerns related to facilities, research infrastructure, and research mentor quality, and these concerns are not trivial, the program should examine strategies to achieve higher levels of inclusion for these community groups.

PRFB applicants and awardees overwhelmingly identified research-intensive institutions for training platforms. While this is to be expected, to address issues of human resource capital disparity at MSIs, and potentially build infrastructure to increase participation in other DBI and BIO programs at these institutions in the future, the program should investigate strategies to incentivize PRFB awardee affiliation with these under-served academic communities. Offering a third year of funding to PRFB fellows that spend a year teaching or conducting research at an MSI could be one such approach. HRC leadership and POs could consult with their counterparts that manage the TCU and HBCU program to synergize outcomes.

F. Balance of innovative/potentially transformative/risky projects

Within the scope of the CoV, the REU sites program updated the solicitation to request that more students from small non-research intensive colleges, MSIs, and community colleges be included in proposed programs. The sample jackets did include several proposals that included institutions from these communities and the reviews occasionally labeled these as potentially transformative, however, there were generally hesitations on the part of the review panels to recommend these awards due to concerns with infrastructure and/or facilities or because there were questions about the scope of scientific research being proposed. Though the resulting funding decisions were understandable due to these concerns, the CoV recommends that the program explore potential ways to leverage the enthusiasm of these schools and investigators to engage them in the program while ensuring the high standards for this program that ensure a productive experience for the participants. One strategy might be to encourage program partnerships between multiple hosting institutions to share research infrastructure. This approach was noted in one of the two awards to a partnership of TCUs; the committee commends the program for supporting this type of programming innovation, and encourages investment in these types of awards in the future.

G. Balance of awards for inter- and multi-disciplinary projects

As mentioned previously, the REU Sites are extremely strong in including inter- and multi-disciplinary projects and several are truly innovative in their blending of biological sciences and other scientific disciplines in an effort to train students in cross-cutting STEM skills. The CoV recommends that this be continued. The PRFP had a track that included projects that represented the intersection of biology and math, but this was discontinued. Some of the proposals under the broadening participation and collections strands of the PRFB program did include interdisciplinary components in the research, and these appeared to have drawn the support of the review panels and PO.

H. Balance of Awards for projects that integrate research and education

Integration of research and education remain a primary focus in the RCN-UBE program. Returning the one year teaching supplement to the PRFB program would increase this focus in this research-intensive training program. The REU program, by exposing undergraduates to a

structured research experience as part of their educational experience, remains a flagship example of this in DBI.

I. Balance of participation of groups that are under-represented in science and engineering:

The REU program made a high percentage of awards to URM PIs, as did the PRFB within the Broadening Participation track. The award record for URM PIs in the RCN-UBE program was poor, with only 5% of the awards made to PIs from under-represented groups. HRC should seek ways to engage with potential URM faculty PIs, and increase representation across the award portfolio.

J. Relevance to national priorities, agency mission, disciplinary fields and other constituent needs

The programs in HRC are generally well-aligned with national priorities. The charge from the 2013 CoV report on this topic however, remains a salient point in 2016: *All programs are encouraged to develop appropriate mechanisms to maintain relevance to the community, the agency, and constituent needs.*

OTHER TOPICS

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

Refining existing programs to increase representation of URM faculty and students should remain a focus of DBI, in order to ensure that the best and brightest are participating in the STEM enterprise.

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.

No comment.

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

See comments on the Grand Challenge of broadening participation. While the new INCLUDES program has promise, data and experience show us that targeted investments in the careers of individual scientists and scholars from under-represented communities has measurable and lasting broader impacts.

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

No comment.

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

Sample data set was terrific, however, some actions were not as helpful to the CoV deliberations. Among the awarded actions, there were awarded proposals as well as supplements and notes on forward funding of specific proposals. Inclusion of these other actions diluted the number of awarded full proposals that were in the sample data set for review.

Research Resources Cluster

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(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? Most reviews in ABI, MRI, IDBR, FSML, and CSBR were provided by panelists with only occasional added ad hoc reviews. This appears to be standard practice for proposals submitted to the Research Resources Cluster and is a practical means of getting the proposals reviewed by at least three individuals. The downside is that the panelists typically have expertise in the resource area of the panel (e.g. FSML includes many field station directors and ARI has many engineers) rather than in the broad theoretical framework and domain knowledge of the research questions being addressed through the investment in infrastructure and human resources. The addition of ad hoc reviews could supplement the review process with this expertise. We understand, however, that this would greatly increase the time and resources required of program officers during the pre-panel phase. ABI and FSML supplement proposals were reviewed internally only, which is appropriate.	Yes

The FSML workshop proposal was reviewed only by ad hoc reviewers, which is appropriate. **Data Source: EIS/Type of Review Module**	

2. Are both merit review criteria addressed
 	
    a) In individual reviews?
CSBR, FSML, MRI: yes
IDBR: missing BI in one review
ABI: missing BI in one review
 	
    b) In panel summaries?
Some panel summaries for ABI and FSML were brief, but relied on greater detail in the individual summaries.
 	
    c) In Program Officer review analyses?
Program officer review analyses always comment on the extent to which both merit review criteria are addressed in reviews.
 	
For most proposals, the PO review analyses were generally excellent. They fully summarized the proposal, strength, and weaknesses. The "Basis for Program Recommendation" was almost always a thorough and convincing explanation for the decision taken.
 	
It is apparent from review of proposal jackets that reviewers are embracing the new merit review criteria (introduced at the start of the CoV period) of reporting on both intellectual merit and broader impacts of the proposed work in the context of the five review elements. Most reviews addressed the 5 subcriteria but these were not itemized.
 	
Data Source: Jackets
	a): CSBR, FSML, MRI: yes; IDBR: mostly yes; ABI: mostly yes
	
	b): ABI, CSBR, FSML, IDBR, MRI: yes
	
	c): ABI, CSBR, FSML, IDBR, MRI: yes

3. Do the individual reviewers giving written reviews provide substantive comments to explain their assessment of the proposals? The written comments span the gamut from lengthy and substantive comments on the strengths and weaknesses of what is being proposed, to very short (or missing), non-substantive remarks. The former comments are helpful to PIs for understanding the panel recommendation; the latter aren't. Typically, the problem lies with 1 out of 3 reviews. We found particular lapses in ABI (nearly 1/3 of proposals examined), and a few problems in MRI (ca.	Variable: Some problems in ABI

10%). Overall the reviewers can be largely commended on their work in providing substantial feedback to the PI's via the panel review process. While program officers have limited control over the content of individual reviews, more education of prospective panelists might help to encourage 100% of the reviews to be substantive. Instructions to reviewers about what to look for in the broader impacts section of proposals (e.g. pro-active as opposed to passive statements) may also be conveyed via webinars preceding the panel review.	
FSML, CSBR: In general, the individual reviews were thorough and substantive, especially the ad hoc reviews. In FSML, broader impacts were given only brief attention in ca. 15% of proposals.	
IDBR: Most proposals were fine but for one , all three reviews were sketchy.	
ABI: Individual reviews tended to be less detailed for many of these proposals, and in some cases were terse or bulleted. In more than 1/3 of the proposals, at least one review lacked any substantive detail on either intellectual merit or broader impacts.	
MRI: Only about 10% of more than 66 reviews were not sufficiently substantive to explain the score given to the proposal. Examples of a high score while still including a significant list of weaknesses in IM were present. However, in one case, all three reviews were not substantive, but according to these reviews, the proposal itself seemed to lack sufficient detail for reviewers to comment on. This lack of detail was also mentioned in the Review Analysis of this particular proposal.	
Data Source: Jackets	

4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)?	
FSML, CSBR, MRI: In most cases, the panel summary provides the rationale for the recommendation. In cases where the recommendation doesn't fit the reviews (e.g., a rating of highly meritorious, with a mix of strong and weak reviews, or strong reviews and a non-competitive rating), weaknesses summarized in the panel summaries often provide the rationale for this (a different consensus coming out of the panel discussion than suggested by the reviews).	Variable**:** Some problems in ABI, IDBR
IDBR, ABI: We found that panel summaries were poorly written, sketchy or inconsistent in ca. 15% of IDBR proposals and ca. 20% of ABI proposals.	

Quality of panel summaries is critical because it is the primary means of communicating NSF's decision to the PI. The program officer has control of the quality of the summaries and should enforce inclusion of meaningful detail. **Data Source: Jackets**	

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.] **ABI, CSBR, FSML, IDBR, MRI**: The information in the jacket (context statement, reviews, panel summary, context statement and the program's review analysis) does, in the aggregate, provide the rationale for the award/decline decision. The context statement provides general information about the competition (number of proposals and breakdown of proposal ratings, and general information about the reviews and panel summary. The reviews and panel summary vary in how well they provide rationale for award/decline decisions. Panel summaries are consensus opinions reflecting panel discussions and tend to be better than individual reviews but this varies. The Review Analyses generally convey strengths and weaknesses as well as the rationale for decisions much more clearly than do reviews and panel summaries. There was occasionally a disconnect between the summaries and the Review Analysis. In particular, some of the MRI proposals we read were ranked highly meritorious and this was reflected in the comments within the panel summary. However, these proposals were declined, and the reason for declination was only clear from the Review Analysis which appears not to have been communicated to the PIs. **Data Source: Jackets**	Yes

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.]	
See comments above under questions 4 and 5. In most cases, the panel summary and consensus reflected in the summary were consistent with the award/decline decision. However, there are cases in which the final funding decision was not fully consistent with the rankings and individual reviews. In these cases, the information that the PI would have received probably was not sufficient to explain this discrepancy.	Variable: Some problems found in ABI, IDBR, MRI
In just about every case, the Review Analysis provided by the program officers provides clear rationale for the funding decision, but the Review Analysis is not sent to the PI. This information would be very valuable to PIs who need to decide whether to re-submit their proposals for example. The Review Analyses were particularly detailed for the MRI program and provided the most information about the award/decline decision.	
Recommendation: DBI (or all of BIO, as appropriate) should consider sharing the Review Analysis with PIs through a PO comment with the panel summary or through proactive follow up.	
Data Source: Jackets	

7. Additional comments on the quality and effectiveness of the program's use of merit review process:	
The quality and effectiveness of the merit review process in Research Resources programs are generally high. In general, the reviews suggest that reviewers are becoming comfortable with the new merit review criteria. An appreciable minority of the reviews in our sample address intellectual merit and broader impacts in the context of the five elements. Investigators are doing a better job addressing broader impacts in their proposals. Some do an outstanding job; others address standard BI areas but do not present effective plans for activities. Reviewers are becoming more critical of cases in which investigators are vague about BI plans.	
In general, POs could do a better job of being sure that panel summaries are sufficiently detailed before approving them.	
The use of additional review criteria specific to the program under review (e.g., criteria pertaining to management of the instrument facility and the dissemination to and impact of the instrument on the Biology community in IDBR and MRI) are particularly good to keep the program focused on its	

mission to provide useful resources for the BIO community. Reviewers comments with regards to these specific criteria should continue to be required as part of the review process.

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? **ABI, CSBR, FSML, IDBR, MRI**: Overall, Research Resources Cluster assigns reviews with appropriate expertise/qualifications for reviews. Program officers routinely use personal knowledge of the research community, internet searches (e.g., Pubmed, COS, SCOPUS, etc.), the NSF reviewer database, and PI suggestions in the reviewer selection process. Program Directors were encouraged to diversify their selection of panelists as much as possible to support Foundation-wide broadening participation goals (race, ethnicity, gender, age, geography, institution types, etc.). Panels were then reviewed and approved by Division leadership to ensure that a good effort was made in keeping the panel reviewers as diverse as possible. Based on examination of sample jackets (for the ABI, CSBR, and IDBR programs) at least one of the panel reviewers had expertise appropriate for the research being proposed. Ad Hoc reviewers, who generally are expert in the subject matter of proposals, are not used very often in Research Resources Cluster (based on samples of proposals in the CSBR, ABI, and FSML programs). For FSML, all reviewers were panelists who tended to have strong associations with field stations. In one ABI EAGER award, the PO did a good job of getting advice from other POs including outside DBI. **Data Source: Jackets**	Yes

2. Did the program recognize and resolve conflicts of interest when appropriate? **ABI, CSBR, FSML, IDBR**: In general, programs in Research Resources do an effective job recognizing and resolving conflicts of interest (COIs). COIs are reported in Review Analyses. COIs, whether for panelists or program officers, are reported along with the actions taken. **MRI:** A few COIs were noted in the panel summary or Review Analysis. These were typically either identified beforehand or at panel. In one situation, a review with a coi that was identified later on the process was not considered in the funding recommendation. **Data Source: Jackets**	Yes, but see comment on MRI

3. Additional comments on reviewer selection: In general, the reviewer selection process in Research Resources programs is quite good, except for a disproportionately low racial diversity of reviewers. According to the DBI Self Study, reviewer ethnicity data was only available for 57% of reviewers (764 individuals) of which 4% reported Hispanic or Latino and 4.4% reported African American, Native American, or more than one racial category. Gender information was more available, with 9% declining to provide gender information, 34% reporting as female, and 57% reporting as male. No data were available on how often reviewers or panelists were recruited from Minority Serving Institutions (MSIs), regardless of race, and how often these individuals accepted or declined the invitations. The CoV wondered if success recruiting diverse panels varies across the different DBI clusters and programs. Is reviewer or panel diversity higher, for example, for the REU Sites program – which has high diversity of program participants - and, if so, why? A challenge attracting reviewers from MSIs may be the heavy teaching and advising responsibilities faculty at these institutions generally have. **Recommendation**: DBI and other BIO Directorates should explore ways of securing teaching releases for MSI faculty as a means of increasing reviewer/panelist diversity. It might be possible to combine diverse reviewer/panelist recruitment with other broadening participation activities targeting MSI faculty.	

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.

In general, the programs seem to be well managed. A complex portfolio of programs is handled by a relatively small number of program officers and support staff. High turnover of staff is built into the system and requires continual attention. Other comments on management are throughout this report.

Advances in Biological Informatics (ABI) is a centralized program in BIO that supports the design, development, implementation, and use of information resources and tools needed to advance biological research in all areas supported by NSF BIO. ABI works closely with other units at NSF, such as the Division of Advanced Cyber-infrastructure (ACI) in the CISE Directorate. Some ABI projects are co-funded by the Software Infrastructure for Sustained Innovation (SI2) program in ACI/CISE, the Information Integration and Informatics program in CISE, and the Mathematical Biology and Statistics programs in the Directorate for Math and Physical Sciences (MPS). The program handles more than twice the number of proposals as other programs in Research Resources.

Collections in Support of Biological Research (CSBR) supports living (stock/culture) and non-living (natural history) research collections. Because of the nature of these collections, stable, predictable funding streams are imperative. However, this program was placed on hiatus for reasons not made clear in the report. The small number of proposals does not necessarily mean that the program is not needed. A high priority is placed on preserving and integrating collection information and developing innovative methods of improving the infrastructure for existing living stock/culture collections and specimen-based vouchered natural history collections that serve a broad community of biological researchers. Activities involving the application of new and improved curatorial techniques and tools related to the maintenance, provision, care, preservation, storage, and data management of collections are encouraged. Digitizing activities such as data basing, geo-referencing, and imaging may be funded as activities designed to secure and improve access to collections. Digitizing activities focused on augmenting or enhancing large volumes of data from well-secured collections are funded by the Advancing Digitization of Biodiversity Collections (ADBC) program.
The Advancing Digitization for Biodiversity Collections (ADBC) program supports the central coordinating organization, iDigBIO, which is funded through a cooperative agreement (Page, #1115210) and is overseen through the Centers Cluster. In addition, the program also supports Thematic Collections Networks (TCNs) and the Partners to Existing Networks (PENs). TCNs are focused on digitizing existing specimens based on a particular research theme that vary from grand challenges for biodiversity to research themes requiring

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information from existing collections. The PENs partner with and further the efforts of ongoing NSF-funded TCNs.

The Improvements in Facilities, Communications, and Equipment at Biological Field Stations and Marine Laboratories (FSML) program supports off-campus facilities that conduct research and education activities in the natural habitats of terrestrial, freshwater, and marine ecosystems. FSML provides facilities and equipment in close proximity to these study areas, and fosters an atmosphere of mutual scientific interest and collaboration in research and education. Two tracks are supported: Improvement and Planning. Improvement proposals focus on well-defined projects of major equipment acquisition, data management and communication systems modernization, or physical plant improvement. Planning proposals focus on strategic institutional planning for the long term research and education goals of the station.

The Instrument Development for Biological Research (IDBR) program supports the development or major improvement of instrumentation for biological research. IDBR accepts two types of proposals: Innovation and Bridging. Innovation proposals focus on the development of novel instrumentation that provide new research capabilities or, where appropriate, that significantly improve current technologies by at least an order of magnitude in fundamental aspects such as accuracy, precision, resolution, throughput, flexibility, breadth of application, costs of construction or operation, or user-friendliness. Bridging proposals focus on transforming 'one of a kind' prototypes or high-end instruments into devices that are broadly available and utilizable without loss of capacity. Almost all IDBR awards engage students from engineering and biology disciplines in instrument design, development, and validation. This program was just put on hiatus for evaluation. The reasons for this or the metrics of the evaluation were not clear during the CoV visit. This is likely to negatively affect several areas of biology, especially areas such as ecosystems and basic molecular biosciences other than neuroscience, for which there does not seem to be a targeted instrument development program. Instrument development specifically targeting the biological sciences is critical to promoting new discoveries and advancing knowledge by improving the methods of data collection as well as the quality of the collected data.

The MRI program is a foundation-wide program co-managed by OIA and other directorates or divisions of NSF. It serves to increase access to shared scientific and engineering instruments for research and research training. The MRI program provides a unique opportunity for institutions to acquire significant research instrumentation for shared use that, in general, is too costly or not appropriate for support through other NSF programs.

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

During the CoV period, the Research Resources Cluster showed a trend of funding more grants focused on networking and standardization across researchers/research sites. This was especially apparent in ABI and FSML. DBI's programs are well-suited to catalyze collaborations across the community through these efforts.

Funding by ABI during the review period, for example, reflected a movement within the BIO community toward shared cyberinfrastructure as opposed to local desktop tools. Shared cyberinfrastructure uses "gateway"-type resources based on web services or standardized Application Programming Interfaces (APIs) that enable community-wide access to algorithms, models, and computational infrastructure. The cyberinfrastructure serves communities such as phylogenetics, biodiversity, neuroscience, and synthetic biology. ABI also made significant investments in expanding the nation's data infrastructure including renewed support for long term repositories like Protein Data Bank (a 44-year investment of NSF, NIH and DOE) and investment in new resources supporting the plant genome, Arabidopsis, evolutionary biology, and biodiversity. Finally, two data resources previously supported by ABI, TAIR (#0850219) and Dryad (#1612608) successfully implemented new fiscal models under which a significant portion of the ongoing operating costs are sustained through community-directed cost recovery solutions.

During the CoV review period, the FSML program also moved toward shared science and networking: The program worked with the BIO OAD to commission a study by the National Academy of Science as a follow up to a previously funded strategic plan written by the Organization of Biological Field Stations and the National Association of Marine Labs. Awards made in the FSML program during the review period reflect some of the vectors of change discussed in this document: planning grants that focus on regional, multi-institutional networks, collaborative proposals seeking to deploy common instrumentation to harmonize data collection over wider areas, and requests for infrastructure to participate in regional and even global observing or experimental networks such as Global Lakes Ecological Observatory Network (GLEON).

In FY13, the CSBR program was moved to a biennial cycle. However, a competition was run in FY14, in effect returning the program to an annual competition during the CoV period. During the period under review, DBI encouraged and funded a number of activities to help enable strategic planning and the further development of a collections community of practice, including the Biodiversity Collections Network (BCoN), RCN (#1441785), the US Culture Collection Network RCN (#1534564), and the Biological Collections as a Resource for Technical Innovation workshop (#1521072). CSBR program staff also published NSF 15-99, a 57-page bound color booklet that highlights several of the program's investments and their impacts.

The ADBC program was moved to DBI during the second half of FY15. Managing ADBC in DBI facilitates integrated oversight, leveraging, and complementarity of collections-related infrastructure investments made through the ADBC, CSBR, ABI, and PRFP programs. In FY15, a critical mass of digitized collections information from TCN's continued to become available through iDigBio's online portal (http://portal.idigbio.org/), which now includes over 64 million specimen records and almost 15 million media records. DBI developed a new track in the PRFP program to help encourage the next generation of professional scientists to develop novel uses of our nation's collections (including digitized collections data).

During the CoV review period, the IDBR program supported workshops that fostered interdisciplinary collaborations in instrument development and promoted best practices in knowledge transfer and dissemination. An award was made for a workshop to foster collaborations between engineers and biologists in the development and deployment of animal and environmental sensors. A second workshop awarded in 2014 helped researchers engaged in instrument development to: 1) foster collaborations with biologists, 2) engage scientists in interagency collaborations, 3) identify innovative entrepreneurial activities for instrument dissemination and commercialization, and 4) develop best practices in education and outreach.

DBI's MRI program is uniquely positioned to review proposals and make funding decisions that enhance the research capabilities of laboratories conducting important biological research. Examples have included the development of platforms to monitor plant phenotypes both in the field and in the laboratory, providing numerous small and large institutions with state-of-the-art imaging capabilities, enhanced computational infrastructure, and biological sensor capabilities across all scales, from monitoring intracellular chemical reactions to the movement of large animals in aerial, terrestrial, and aquatic environments.

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

DBI developed a noteworthy and interesting working model to assess its portfolio (see page 11 of the DBI Self Study). This model needs to be tied more directly to specifics so it can guide future decisions. Specifically, the self-study defines a 3-dimensional space, and it would be informative to see where the portfolio of each program lies in this space. No individual program can be expected to span the whole space, but the entire portfolio of programs should do so. DBI should better justify the balance of its portfolio along the spectrum from innovation to sustainability. It would also be important to consider how the programs in DBI might ultimately impact areas other than BIO along the scope axis.

Program planning and prioritization are ongoing activities in DBI, and planning and prioritization activities are clearly evident in the discussion of the strategic plan in the self-study report. However, the entire directorate, in conjunction with the front office, needs to do a better job of analyzing evaluation data and metrics as well as transparently using them to make decisions. DBI programs collect a substantial amount of highly informative assessment metrics that are critical to guiding important decisions affecting the DBI portfolio. These data as well as the results of outreach to the BIO community are significant and should be evaluated on an ongoing basis prior to ending programs or placing them on hiatus. However, despite these deliberate efforts to collect information to guide the portfolio, it also seems that some portfolio-related decisions were mandated by the front office; if they were driven by data this was not apparent to the CoV. This in turn may lead to

narrowing the portfolio of DBI and threatens to decrease or eliminate its wide and long-term relevance to all BIO areas.

Timely and regular data-sharing within DBI, across BIO divisions and between DBI and the front office should be required in order to pointedly guide the portfolio and make sure that it remains relevant to the mission of DBI within BIO and NSF. New scientific inquiries and endeavors seem to move at a faster pace than infrastructure development. Because of this, DBI needs to keep a birds-eye view of the scientific landscape while trying to respond to short- and long-term changes. Ideally, the infrastructure developed in DBI should be accessible and applicable to as many areas of BIO as possible so as to remain relevant over the long-term, even in the face of changes in the direction of scientific inquiries.

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

DBI has made a serious effort to respond to the comments of the previous CoV (Note that statements from the 2013 CoV appear hereafter in italics). Some of the responses have been notably successful, others less so. In a number of cases, previously identified issues persist.

The most successful changes are as follows:

1. The CoV process. While the 2013 CoV "*found particular challenges with the mechanics of the CoV process*," these have been fully rectified this year and we congratulate the DBI staff on producing an exceptional trove of data that made the task of the CoV straightforward. Issues of program balance across sub-disciplines are now fully addressed.

2. The quality and effectiveness of the merit review process. In general, the 2016 CoV found that the review processes improved since the previous evaluation. The 2013 CoV found numerous problems with documenting and conveying to PIs the rationale for awards and declines in both Panel Summaries and Review Analyses. In the research resources cluster, we found that Review Analyses were almost uniformly clear and informative. Even with "routine" declines (i.e., where the decline decision was unambiguous), major reasons for the decision were listed. Panel Summaries were somewhat more uneven, but even in these, the problems only appeared in a minority of proposals. The ABI program seemed to have more challenges in this regard. Broader Impacts are now addressed almost universally, although not always in detail. One potential solution to minimize the discrepancy between the Panel Summary and Review Analysis would be more frequent use of program officer comments appended to the summary that the PI receives.

3. Connections between the disciplinary programs and the infrastructure and human resource programs of DBI. This appears to be improving. Brown bag lunches were highlighted positively by other divisions. Increased frequency and regularity of these activities could further improve connections and communication.

4. Managing synthesis centers. Steps are being taken in the right direction. Appointment of a Science Advisor is one positive step, as is aggregating the Centers in their own cluster in DBI. POs are being encouraged or required (as appropriate) to engage in formal training in project management. Because of the enormous size of the NEON investment, this is going to be even more critical in the future.

5. Communications. DBI has gone a long way in improving this, and the CoV heard many positive comments from various constituencies. This issue is ongoing however, and some statements from the previous CoV remain relevant. The committee heard from several sources about the need for better communication between the Division and the front office, particularly as regards creation or termination of programs.

6. Broader impacts. The 2013 CoV noted that "*Broader impacts, overall, are not well attended to by reviewers or PIs.*" The 2016 CoV felt that Broader Impacts were generally addressed fairly well, although some of the reviews and panel summaries provided somewhat cursory evaluations.

Other areas present issues that appear not to have been addressed, or that represent ongoing problems.

1. Metrics for measuring progress. From 2013 CoV: *Self-reflection and measurement of progress. We recommend that DBI and the Directorate develop effective mechanisms through which they will track their progress on the recommendations that emerge from processes such as the CoV. Documentation should detail how each level of the Foundation responds to recommendations, as appropriate.*

It is not clear that this has been addressed, although the 2016 self-study does serve this purpose to a certain extent. Annual reports could also provide such metrics but appear not to be used in any rigorous or consistent way.

2. Program impact and portfolio balance. From 2013 CoV: *Metrics of program impact on the biological research community were not presented and should be developed for each program. Balancing portfolios will become increasingly difficult as some programs have increased in their mission and so panel composition must reflect a broader constituency. With respect to collections, proposals for smaller collections appear to receive less ecumenical reviews given the balance of institution representation on the panel.*
The 2016 CoV did not see much improvement in the Research Resources Cluster's impact on the research community or much change in the portfolio balance since the last CoV report.

3. Expanding the reviewer and PI pools. From 2013: *Research resources programs should develop outreach programs to engage PUIs, MSI/HBCU, and non-academic institutions and PIs to provide breadth and diversity to the reviewer and PI pools. Long term sustainability of digital and physical assets are also of concern and it appears that this concern has not been adequately been addressed.*

This is still a problem although the 2016 CoV has some specific suggestions in this regard. The CoV recommends that DBI, and BIO as a whole, explore creative means of encouraging more PUI/MSI faculty participation on panels. A challenge that these faculty members face with participating in the panel process involves devoting the time necessary to review proposals and travel for panel service on top of their often heavy commitments to teaching and advising students. A possible solution would be establishing a research initiation-type funding opportunity specifically focused on faculty at PUI and MSI institutions, which provides a one-semester, one-course teaching release to each recipient. Such release time would allow the recipients to serve on an advisory panel (a requirement of the award), and allow recipients to devote the balance of the release-time to establishing an extramurally-funded research program of their own (gathering preliminary data, preparing proposals).

4. Strategic planning. From 2013: "*the alternate year cycle for the CSBR program does not seem to have been based on a documented assessment of program impact. Further, it is not clear that evaluation criteria are available to determine if award sizes are appropriate. Does the division have a strategic planning process for acknowledging divisional priorities, determining funding allocation, and evaluating the relative success and impact of programs, in the context of community needs? It is not clear that proposal pressure, based solely on proposal load, should be the only metric used in determining program impact and effectiveness.*" And "*a mechanism must be applied to evaluate program longevity and it could be argued that re-invention of programs may be needed.*" And "*In some cases there were gaps in funding (FSML hiatus) and delays in implementing awards though the vast majority occurred within the 6-month dwell time, this appeared to be the case primarily for awards with declines processed quickly. There was concern with the move to hold CSBR competitions biennially, …. We strongly recommend that annual competitions be re-instituted.*"

This is still a problem and remains one of the highest concerns of the current CoV. While the community might be sympathetic to decisions about changing funding cycles for some programs, input was not requested and the reason for programmatic decisions was not communicated effectively to the Divisions, POs, staff, and out to the broader community. The CoV was informed that the CSBR program is undergoing an evaluation to assess program impact and effectiveness.

5. High-risk, high-reward proposals. From 2013: "*In some cases the decisions appear risk averse and opportunities to fund high risk/high payoff projects were not taken. For a few of the programs, however, innovation is a core tenet of the programs and the portfolio represents this core value.*" and "*Catalyzing new investments requires taking risks in research infrastructure. The programs should be encouraged to support innovation and high risk/high payoff projects. In addition, long term commitment to programs can enable innovation and sustain products and programs that support the community. For example, the cyberinfrastructure and database curation challenges that are presented by DBI programs*

> *and Centers may benefit from incorporating strategies to facilitate incubation of novel approaches and assist in leveraging opportunities across directorates.*
>
> The Self-study indicates that the word "transformative" appears almost twice as often in the panel summaries of awards as it does in declined proposals. However, there is also the possibility that panels may add the word "transformative" to help a proposal get funded.

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).*

A. Balance of awards across disciplines and sub-disciplines of the activity

Of the proposals considered by the Research Resources Cluster during the CoV period, 621 were awarded: 27 by the ADBC program, 226 by ABI, 77 by CSBR, 88 by FSML, 119 by IDBR and 84 by MRI. In terms of dollars, ADBC awards during the CoV review period totaled $ 6,615,864 (2% of all DBI funded awarded), ABI awards totaled $ 178,552,931 (59%), CSBR awards totaled $ 22,461,077 (7%), FSML awards totaled $ 13,221,280 (4%), IDBR awards totaled $ 44,574,795 (15%), and MRI totaled $35,466,300 (12%). Clearly this distribution shows a strong bias toward digital and bioinformatics support, with the majority of the RR Cluster funds going to a single program (ABI). Instruments and large equipment (IDBR and MRI) comprise more than a quarter of the remaining funds. This leaves a small remainder for the program whose awards tend to have some of the broadest use among the community (FSML and CSBR). Moreover, these two programs seem most vulnerable to changes in their timing.

Assessing the balance of awards across biology disciplines and subdisciplines is a challenging task. In its effort to analyze this, the DBI Self Study first used the BIO proposal classification form, which has 77 terms describing sub-disciplines of the biological sciences and 9 terms describing sciences outside of biology. PIs are requested to check all terms that they believe relate to the proposed project they submit. The Self Study gives a caveat that it is difficult to make any strong conclusions from these data. However, one can see in the results (Table 12) that DBI makes awards across many biological subfields that align with MCB, IOS, or DEB. Moreover, some areas such as "StatMethod" seem to be unique to DBI. The other analysis presented in the Self Study is a text mining exercise that indexed all the words and phrases in proposal summaries, project descriptions, and titles and automatically generated a set of topical tags that describe the proposal content. The authors then compared the core research

Divisions in BIO to assess the degree to which the top 100 most frequently used tags overlap among Divisions. The rationale was that each BIO Division serves a distinct purpose in the Directorate and that by comparing the 100 most frequently occurring tags we can identify key areas of complementarity or specialization.

Proposals in DBI accounted for only 11% of the total set analyzed, but included 75% of the tags, suggesting broad topical distribution across all biological disciplines. An interesting Venn diagram included in the report (Figure 4) showed that the extents of topic-tag overlap among all BIO Divisions was both considerable (average of 29%) and consistent (range 27% -32%), as would be expected for a multi-disciplinary infrastructure division aligned to serving BIO as a whole. Other divisions had considerably less topic overlap (e.g., DEB and MCB only shared 6% their top 100 sets). In this analysis, there were 6 tags shared amongst all BIO Divisions and those tags relate to fundamental themes in biology and peer review (whole genome, genome sequence, gene expression, genetic analysis, specific aims, preliminary data).

B. Balance of award size and duration

The Research Resources Cluster funding rates were 18% for MRI, 27% for ABI and IDBR, 39% for CSBR, and 50% for FSML during the CoV period. These success rates compare relatively favorably to the BIO directorate-wide (23%) and agency-wide (23%) funding rate from 2013-15 (Report to the National Science Board on the National Science Foundation's Merit Review Process, Fiscal Year 2015). In addition, DBI tended to make awards at close to the level of the requested amount across all programs in the cluster. This is very positive and motivating for the research community.

The average size of awards varied among the RR programs by almost three-fold. FSML awards were the smallest for all programs, averaging less than $200,000 per award. However, if the FSML awards for less than $25,000 (mostly for planning activities) are removed, the average award size in this program increases to $237,000 with the largest award during the period being $356,000. CSBR awards averaged $377,000 when awards less than $25,000 were removed. MRI awards also averaged $377,000 when an outlying $2.8 million award was removed (there were no MRI awards of $25,000 or less). IDBR awards averaged $455,000, also with no awards of $25,000 or less.
ABI has the largest awards of all programs, averaging $596,000 after the removal of awards of $25,000 or less and a $32 million award to support management of the protein bank. Grants of $25,000 or less represent 28% of all awards in FSML, 2% of CSBR awards, and 4% of ABI awards. This general distribution of award size – with ABI grants being large and FSML being small – are generally consistent with the trend discussed in the previous section. It is interesting to note that two programs that used small grants extensively (though the former much more than the latter) – FSML and ABI – where the largest and smallest programs. It would be interesting to evaluate the success of small-scale funding and consider whether it would be valuable to incorporate into other types of programs as well, such as the development of instrumentation.

The average award duration for all programs with the Research Resources Cluster was approximately three years for all programs except for FSML, which was closer to a year and half. During discussions with program officers, it was mentioned that the award duration is sometimes longer than the expected time to complete the project. One reason is the development or acquisition or construction of facilities often takes longer than initially expected, due to unexpected impediments. (The recent introduction of Performance Evaluation Plans is meant, in part, to improve the ability to manage for such situations.) The second advantage of a longer duration period allows for time to report on accomplishments of the award, for example usage of equipment, software, or facilities. One possible recommendation is for all DBI proposals to require reporting after a certain period to better evaluate the success of the infrastructure investment.

C. Balance of awards to new and early-career investigators

Of the three clusters in DBI, Research Resources received the greatest proportion of proposals from beginning investigators (16% of all proposals) and the highest funding rate (22%, though this was still less than the average funding rate of 29% for all proposals in RR). The only program in which beginning PIs had a higher success rate than all PIs was MRI (22% vs 18%). Early Career grants were only submitted to ABI and IDBR, but for both programs, the funding rate for these grants was higher than the average across the program. The funding rate for Early Career grants is encouraging. We recommend that DBI continue to monitor funding rates for beginning investigators in other programs. The relatively low rate may reflect the inexperience of young PIs in writing grants, but it is also likely to be very discouraging.

D. Balance of geographical distribution of awards

The geographical distribution data found in Table 15 of the self-study document was divided into data pertaining to HRC and RRC. This grouped data can be found in the document "Cluster EPSCoR" in the eJacket. These data indicate that for non-EPSCoR projects, there is an overwhelming number of awards to regions concentrated on the east and west coast of the US, particularly California and Massachusetts. The average number of awards per region is 69 with a standard deviation of 58 suggesting the high variability in number of awards per given region. However, when the number of awards is normalized to the number of submissions, the normalized number of awards becomes more uniform across geographical regions with an average of 31 +/- 7% funding rate. Connecticut's funding rate after normalization to number of submissions was still 17%. The reason for, or significance of, such outlier data is unclear.

The number of awards for EPSCoR projects is less uniform across geographical regions even after normalization to number of submission, with 25% +/-15% funding rate. New England states, Alaska and Hawaii were the highest recipients for the EPSCoR projects. An analysis of the data to explain the discrepancy in success rates within the EPSCoR states group could help inform why such discrepancies arise and further help eliminate them if possible.

E. Balance of awards to different types of institutions

Based on the data provided in Tables 16-18 which include all clusters, institution-type representation as part of the total number of awards is similar for applications and awarded grants. Moreover, the number of awards normalized to number of applications is similar across all institution types except for Community Colleges which have a lower success rate. However, this average representation was not uniform across clusters. The RRC, for example, had a much lower representation of institution types other than PhD granting and Medical Schools compared with the HRC. It would have been helpful if the data presented in the Self-Study report were organized by cluster for this analysis.

F. Balance of innovative/potentially transformative/risky projects

Identifying projects that are innovative, transformative or risky is not possible with the Golden Data spreadsheet. While these terms do appear in reviews, they are not always correlated with funding success. The Division has provided examples of innovative research projects funded through programs in both the HR and RR clusters in the annual reports that can be found in the CoV module in eJacket. It also carried out a text mining exercise for the self-study to determine whether a panel that discussed and wrote about the "transformative," "risky," or "innovative" nature of individual proposals in a panel summary may be associated more strongly with proposals that were recommended for awards or declined, which is summarized in Table 13 of the Self Study. The term "transformative" appeared in 10.8% of panel summaries of proposals that were awarded but only 6.8% of proposals that were declined. The term "risk" appeared in similarly low percentages of panel summaries regardless of whether proposals are awarded (5.7%) or declined (5.4%). The term "innovative" appeared in high percentages of panel summaries, but the percentages were slightly lower for awarded proposals (26.90%) than declined proposals (29.50%). It is difficult to generalize about the significance of these findings without understanding the context of the use of the terms.

G. Balance of awards for inter- and multi-disciplinary projects

Using the *"Fields other than BIO 1"* Flag within the pivot table for the RRC, 1622 out of 2141 proposals (76%) represented a field other than BIO. An impressive variety of fields were represented including computer science, engineering, physics, astronomy, chemistry, and geosciences. The programs that included the highest number of proposals from disciplines other than BIO were ABI and IDBR followed by MRI and Field Stations. This reflects another aspect of the unique and significant position that these particular programs in DBI play in fostering widely interdisciplinary collaborations.

H. Balance of awards for projects that integrate research and education

Compared to programs in the Human Resources Cluster, all of which have a focus on integrating research and education/training activities, programs in the Research Resources cluster fall far short in this regard. Nevertheless, good percentages of proposals submitted to the ABI (39%) and MRI (22%) programs involve education/training activities. The percentages are much lower,

but respectable, for the CSBR (9%) and FSML (8%) programs. Biodiversity collections and field stations and marine labs do provide great education and training opportunities, but only small percentages of proposals submitted to these programs involve training and education activities.

I. *Balance of participation of groups that are under-represented in science and engineering*

It would have been helpful if the data presented in the Self-Study report were organized by cluster for this analysis. Data from the Golden Dataset indicate that the proportion of proposals awarded to minority PIs is low: 2% for FSML and ARI, 4% for ADBC and CSBR, 6% for MRI, and 8% for IDBR. However, funding rates for PIs from under-representative minorities seem to be fairly comparable to overall funding rates: FSML funding rate of minority PIs to all PIs was 33% versus 51%; ABI was 27% vs 28%; CSBR was 43% vs 41%; IDBR was 38% vs 28%; and MRI was 14% vs 18%.

Substantially less than half of RRC grants were awarded to female PIs, including 26% in FSML, 26% in ADBC, 27% in ABI, 32% in CSBR, 22% in IDBR, and 31% in MRI. However, this was largely due to a lower submission rate by female PIs. The funding rate for females was higher than that for all proposals in the cluster: the FSML funding rate of female PIs to all PIs was 66% versus 51%; ABI was 37% vs 28%; CSBR was 44% vs 41%; IDBR was 34% vs 28%; and MRI was 22% vs 18%.

However, PI information represents only one aspect of participation. Another aspect of participation by under-represented groups is at the level of project participants other than the PI once awards are made. In this regard, it would help if a dataset analyzing the demographics of participants could be included in the self-study.

OTHER TOPICS

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

The hiatus in the IDBR and CSBR programs has caused two significant gaps within the portfolio of DBI and its response to community needs. Data-driven evaluation of programs should be ongoing and precede the sudden suspension of programs. In addition, the data on which decisions are made needs to be shared to justify the decision.

All program areas need to have a portfolio that includes development, a program for short-term sustainability, and dissemination and outreach to the BIO community. For example, the IDBR program supports development and dissemination through a bridge-to-commercialization award, while ABI's portfolio includes innovation, development, and sustainability. Pathways to sustainability should be as versatile as possible. In the case of IDBR, commercialization is ideal to simultaneously achieve sustainability and dissemination. This can be critical for helping innovative infrastructure cross the "technological valley of death". However, a short period of

sustainability without wide dissemination may be necessary to get to the point of commercialization.

Analyzing completed project timelines may be helpful in identifying gaps in funding pertaining to sustainability that could be preventing newly developed infrastructure from rapidly reaching its full potential. For example, issues of sustainability plague bioinformatics projects, in which a developer may produce a powerful algorithm or other informatics tool, but then may fail to develop a user interface (which takes a remarkably long time and often a distinct set of skills) and the product never makes it to an end-user community. Such problems may be intended to be covered by the development stream within ABI, but it is unclear how well it works.

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.

The program's performance in meeting its goals would be greatly enhanced by increased communication and data sharing between DBI and the other BIO divisions, and between DBI and the BIO front office. DBI-initiated efforts towards this end, such as the brown bag lunches mentioned earlier, are beginning to address gaps in communication. However more still needs to be done in this regard. For example, we learned in our meetings that there was some overlap between funded proposals in ABI and DEB. Two-way data sharing between BIO divisions is critical to minimize this overlap and insure that BIO resources are used in the most efficient manner.

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

NSF could improve DBI's impact on the BIO sciences and communities by engaging in more data-driven strategic decision making regarding the DBI portfolio, analyzing and understanding the dynamics of projects funded by DBI, and assessing the utilization of DBI-funded infrastructure across the entire directorate. Diversification of the DBI budget is also important to make sure that DBI continues to serve the BIO community at large, as opposed to dedicating funding to more narrowly focused scientific initiatives.

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

The staff of DBI are clearly dedicated and talented. They are challenged by frequent turnover in staffing, much of which is inherent in the structure of NSF. The CoV also heard recurring comments regarding inefficiencies when customizing data layouts for different POs with different preferences. This makes it difficult for different staff members to be able to temporarily take over or "fill-in" for someone else when necessary. DBI retreats and team-building activities were organized to improve communication involving the staff. However more should be done in this regard. In particular, it appeared that there was not sufficient follow-through after the DBI retreats. In addition, it appears that some DBI staff are highly interested

in the larger context of the scientific programs and endeavors that they help manage. Although it is difficult for all the staff to appreciate scientific minutia, most if not all were significantly more enthusiastic about learning about the broader impacts of scientific discoveries. It is important that the staff gets involved with the science in this larger context. Drafting the "scientific highlights" for the NFS website or other DBI publications is one example that was given and certainly seems to be one way that the staff can stay connected with the larger mission that they serve. It would be beneficial for DBI to find additional ways to keep the staff positively engaged in the mission of DBI and NSF.

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

As noted above, the CoV appreciated the care with which the self-study report was prepared and the enormous amount of data that was made available. Some of this had been analyzed by the Division, and other analyses were carried out by CoV members. Because of the short time of the CoV meeting, it was difficult to dive as deeply into the data as we might have liked. One possibility for future CoVs would be to highlight the data that will be most relevant to the CoV, and separate it from the other material that the committee is not likely to utilize to address the questions posed. Flags specifically pertaining to the portfolio questions under Part IV and also those used to create the Tables of the self-study could be highlighted. This would allow the CoV to start with the data used for the self-study tables and then proceed to analyze them in more detail for other purposes. As it was, the committee members had to wade through literally hundreds of categories to identify the key variables of interest. Also a detailed key to all "flags" in the Golden data set would be useful.

Centers Cluster

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(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? The review of Centers includes panel reviews for 5 year renewals of centers, site visits (including PI responses) as specified in cooperative agreements, program officer summaries of these site visit reports, and justification for incremental releases of funds based on annual reports. There are internal reviews for supplemental requests for various purposes (workshops, XFM beamtime for CEINT-Duke, F-E-W nexus cyberinfrastructure for SESYNC) and funding to enable project continuation while review of a renewal proposal was underway. Special approval was requested for one center when their supplements caused the project to exceed the DRB-approved spending limits. For the CEIN program, there was one panel review each (Aug-Sept, 2013) and one site visit each (July-Aug, 2015) for two Centers - CEINT-Duke and CEIN-UCLA during the CoV review period. There were no panel reviews for iDigBio during this period because of its transfer from Emerging Frontiers. The panel reviews were non-competitive renewal reviews. Decisions to release incremental one-year funds were based on annual reports. We recommend	Yes

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that these incremental increases be carefully monitored, tied to demonstrated performance on items in the cooperative agreements (as reflected in the annual reports) and tied to an analysis of currently remaining funds on the award. In one case, a center accrued so much in unspent funds that $2M had to be returned to the US Treasury.

A supplement request to a large project to bridge funding between an extant grant and a pending renewal proposal was problematic. The "justification" in the proposal was 4 lines long and did not associate particular research or educational activities in need of support. The Project Summary was 3 lines long, and did not specify intellectual merit or broader impacts. Rather it requested additional funds to continue the work proposed during the previous 5 years. The particulars of work that was not accomplished during the initial proposal are unclear, so the essence of what will be done is also unclear. Given the size of the supplement, heterogeneous reviews of the pending renewal proposal, and vague and brief nature of the narrative, the transparency of the decision making process are questionable. Moreover, the absence of <u>substantive</u> review and analysis by the Program – at least that obtainable in eJacket -- also makes it impossible to understand the rationale for funding such a large supplement.

One large project underwent review for renewal in 2013. The panel included a breath of reviewer expertise spanning biology, chemistry, mathematics and pathobiology appropriate for the diverse topics covered by the project.

One center underwent a fourth year review and second site visit in 2015 to determine its effectiveness and its value to the scientific community as well as to determine whether to renew support for an additional five years. The reviews and summary were overwhelmingly positive encouraging a renewal application.

Data Source: EIS/Type of Review Module

2. Are both merit review criteria addressed **a) In individual reviews?** Individual reviews for one center activity address only intellectual merit and broader impacts, but not the 9 topic areas in the summary. Reviews of one center renewal proposal were heterogeneous in depth and breadth of explicit coverage of the 9 topic areas. Nonetheless, many were	 Yes for "a"

quite comprehensive, and taken together provided an effective assessment of the renewal project. All of the reviews of the another center renewal proposal addressed both criteria quite thoroughly. **b) In panel summaries?** There are 9 specific topic areas addressed in the summary panel reports for two centers, including: Vision and Strategic Plan, Response to National Needs, Range and Modes of Research Activities, Education and Outreach, Communication, Knowledge Transfer, and Informatics, Data Management Plan, Qualifications of Senior Personnel, Organizational Structure and Management Plan and Institutional Capabilities. For one large project, the deliberations about funding the renewal were protracted, necessitating a request for supplemental bridge-funding. In part, this appears to have arisen because of the complexity of the project and very unusual circumstances: (1) consistently low scores by panelists; (2) a final panel recommendation of "Competitive," but with more weaknesses than strengths identified in the panel summary, and only cursory explanation of the final rationale that lead to the funding decision. Consequently, the program initiated an additional review by a team of five scientists (2 from the renewal panel) who evaluated the PIs written responses to questions raised by the panel review (a comprehensive document) as well as the project's potential based on interactions during a site review in December 2012. An exceptionally detailed and comprehensive report arose from the site review, that recommended renewal. The report detailed strengths and weaknesses, and made recommendations for improvement in a number of areas: Vision and rationale; Cyberinfrastructure design and execution; Data management plan; Collaboration; Project management plan; Assessment of scientific impact; Strategic planning; and Education, outreach, and training; Assessment of Education, outreach, and training. Nonetheless, the executive summary did not sufficiently address "risk" and the rationale for understanding how project weaknesses were compensated by the project's strengths. For another center there is a thorough and detailed Panel Summary for the renewal proposal. It is not structured in terms of 5 questions for intellectual merit and 5 questions for broader impacts but rather includes several different sections that touch on either intellectual merit or broader impact or	Yes for "b"

in some cases the integration of the two. This format is appropriate for a renewal is it allows greater context for the comments. **c) In Program Officer review analyses?** In the CEIN program, the PO review analysis is much more extensive and contains a full project description, scientific accomplishments, activities, outreach, including descriptions of leadership team, steering committee. Wide range of backgrounds for reviewers. It does cover the 9 topics.	Yes for "c"

The program officer review analysis for one other center was comprehensive and detailed, and provided a rational for the recommendation to fund the renewal. The review analysis addressed the funding recommendation in light of the preponderance of low scores . Nonetheless, the recurrent identification of weaknesses in panelists reviews, panel summary, and site review assessment should have been recognized in the Review Analysis in a transparent way so as to identify and programmatically minimize elements of risk associated with the management of such a large investment.

The program officer review analysis of a fourth center is again quite detailed. It accurately reflects the general tone of the panel as well as some of the specific details of the individual reviewers. Again it details the few weaknesses were that were noted such as a postdoc mentoring plan deficient in career training and concern about the number of pre-tenure faculty in positions of great responsibility during the turnover in center director position. These are appropriate flags to record. The program officer review analysis states that it includes a "risk assessment and a discussion of post-award management". The post-award management section indicates a Working Group comprised of representatives from several federal agencies. The managing program officer acts as the conduit between the Working Group and the Institute as well as a coordinating hub with other POs within BIO to identify common issues. The risk assessment is not a standalone section of this report but rather peppered throughout the report. This report appears to be an example of the PO training in program management that several POs mentioned during the CoV.

The program officer review analysis of the a fifth center's 4th year site visit report accurately reflects the report in summarizing the strengths as well as the recommendations that the renewal proposal should include 1) A mission statement 2) a Theory of Change 3) a focused set of priorities and 4) projected outcomes and indicators and 5) explicit diversity goals.

Data Source: Jackets

3. Do the individual reviewers giving written reviews provide substantive comments to explain their assessment of the proposals?	
For the most part, individual reviewers provide substantive comments. There was an example where a reviewer gave an excellent rating despite noted weakness such as lack of clarity as to research organization and generalization and lack of assessment in broadening impact activities. Another reviewer recorded a very good despite observing significant weaknesses in implementation details. There is one example a proposal with an excellent rating, but observed lack of data dissemination plans. In general, however, reviewer comments support their assessment.	Yes
Comments about scientific merit were generally more comprehensive and substantive than those addressing broader impacts (e.g., one review of the broader impacts of one project was a one line, descriptive sentence).	
Reviews for the renewal proposal from another center proposal were detailed and consistent. As the Center itself takes a computational approach to quantitative metrics in addition to the standard assessment of impact through publication, the renewal (as well as annual reports) included ample detail on broader impacts in terms of goals and achievements that the review panel could easily process.	
Data Source: Jackets	

4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)?	
Consensus was fairly obvious in two summaries.	Yes
The Panel Summary for a third center comprehensively detailed strengths and weaknesses, but did not clearly provide insight into the way in which these opposing positions were adjudicated to result in a recommendation to fund.	
This panel summary for the a fourth renewal proposal goes beyond the text of the already detailed panel reviews clearly capturing the panel's discussion. While all panel reviews were very positive, and that tone is well captured in the panel summary, it dwells on the identified "weaknesses" providing constructive and specific critique in a way that would be useful to the Center. For example, the panel summary identifies the inclusion of a Diversity Director as a positive but discusses the need to more clearly articulate the role of this	

individual and the target goals. That this panel summary provided useful feedback is witnessed by the following annual report that addresses some of these issues.

Data Source: Jackets

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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.]

For the most part, the jackets for each center grant did contain the necessary information to decipher rationale for the decisions on awards and supplement requests as well as evaluation of annual and site visits reports that led to continued funding. CoV members searching for this information found it frustrating that there were multiple jackets associated with each center and there did not appear to be consistent organization of where the various items were located. For example, the review of an annual report could be located in "Reviews," "Review Analysis," "Correspondence," or "Diary Notes". This lack of consistent organization even among jackets for a single center raised concern that the various NSF program officers and staff who might have reason to access these files would have difficulty following ongoing threads and conversations between NSF and the Center Directors and staff. More consistent organization and file description would aid communication about the program timeline and facilitate assessment of progress from one year to the next on these long term programs that may span multiple program officers.

Data Source: Jackets

Yes

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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.]	
The Panel Review summaries were the main source of documentation to the PI providing the rationale for the award/decline decision. There were few PO Comments, but there was substantial record of minor email correspondences. The site visit reports were very detailed reporting assessment of various program activities, and explaining experiences during the site visit that were useful to the panel in forming these impressions.

Data Source: Jackets | Yes |

7. Additional comments on the quality and effectiveness of the program's use of merit review process:

The concern stated in item I-1 bears repeating here, "Decisions to release incremental one-year funds were based on annual reports. We recommend that these incremental increases be carefully monitored, tied to demonstrated performance on items in the cooperative agreements (as reflected in the annual reports) and tied to an analysis of currently remaining funds on the award."

The extent and depth of review for one project in many ways represented Herculean efforts. Given that review experience, it is clear that considerations of "scientific/intellectual risk" and "managerial risk" should be incorporated as part of the review for large investment projects, with explicit directions for doing so by the Panel, Site Review Team, and Program Review.

From one center, the first end of the year report following the renewal review provided evidence that the panel summary (or program officer) had effectively communicated the panel mild concerns. It identified issues in the center's postdoc program that mirrored comments from a few of the reviewers. This suggests that the center was responsive to the comments of the reviewers and that the program officer had communicated effectively. | |

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? The review panel for one of the renewal proposals included a breath of reviewer expertise spanning biology, chemistry, mathematics and pathobiology appropriate for the diverse topics covered by the center. Similarly, the site visit team included expertise in mathematical modeling, biomechanics, and molecular biology. The site visit team for a second center appropriately included a breadth of disciplinary expertise spanning ecology to philosophy. The two other review panels had a good mix of nanoscale science, engineering, molecular toxicology, soil science environmental biotechnology, geoscience, and biomedical engineering that brought complementary expertise in topical areas. **Data Source: Jackets**	Yes

2. Did the program recognize and resolve conflicts of interest when appropriate? In one instance a coi was managed by the individual leaving the room during the review of the renewal proposal. This was appropriately documented in the jacket. **Data Source: Jackets**	Yes
3. Additional comments on reviewer selection: The vast majority (maybe all) of the renewal reviewers and site visit panels were drawn from large research institutions. The CoV suggests that NSF consider including reviewers that represent a greater the greater diversity of institutions that benefit from such sites, including those individuals with expertise to evaluate the outreach efforts and broader impacts as well.	

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.

Two working groups provide oversight for the CEINs, one made up of POs from all funding directorates (5 directorates plus EPA) reviews annual reports, provides advice on and participates in site visits, and approves annual support. Just the cognizant PO participates in the NSEC center working group. The iPlant working group (PSCIC) comprises five POs (2 in IOS, 2 in DBI, 1 in OCI [CISE]).

The CEINs and iDigBio have annual reports and PO notes summarizing these and indicating why increments were awarded. These were all viewed as highly successful. For centers whose execution is less certain, the division should consider quarterly reports and quarterly conversations with POs. Some materials were more cursory, for example, notes on one reverse site visit listed only who presented and what their topic was.

There are some fundamental challenges with the Centers Cluster. Because these activities are not planned from the outset with staff from DBI, they are disruptive to manage, do not integrate well with activities in the HR and RR Clusters and perhaps do not serve the BIO community as well as they might. In contrast, the CoV heard about a nice example where a post doc program was specifically crafted to make use of new collections being developed. We saw no such overlaps in programs involving any of the centers.

Some centers seem to undergo significant challenges in the first year(s) of operation and sometimes require extraordinary efforts to get back on track. This pattern seems to repeat itself and it's possible that the distractions involved in rescuing one project have a detrimental impact on others that the Centers Cluster is managing. Planning grants to understand better what types of groups are capable of managing such activities before making large multi-year awards would be helpful, as well as more frequent reporting early in the process. Incorporation of risk management considerations in high investment projects from managerial, research, and educational perspectives should be emphasized at all times, but especially during renewal processes.

Centers also face significant challenges in the final years of operation as they transition to independence. In one case, a center accrued so much in unspent funds that $2M had to be returned to the US Treasury." It appears that the Center Director had planned for some time to request a second no cost extension. In this case, because the center is under a Cooperative Agreement a second no cost extension is not allowed. This restriction could/should have been communicated to the Center Director earlier in order to provide time to manage the program more effectively.

More effective planning for the transition phase appears to be incorporated in to the early stages even at the beginning of the five-year renewal for some of the more recent Center awards. For example, at a site visit in 2015, a center described the initiation of active planning for the end of NSF funding. With the very recent transition to a new Center director it was early for formalized plans but conversations were evident and the University was offering strong support in terms of space and additional faculty lines. The Program recommendation for renewal in 2013 states that it includes a "risk assessment and a discussion of post-award management". The post-award management section indicates a Working Group comprising representatives from several federal agencies. The managing program officer acts as the conduit between the Working Group and the Institute as well as a coordinating hub with other POs within BIO to identify common issues. There is evidence in this document that the Working Group was involved in decisions, changes, and ongoing assessment of the center. The risk assessment is not a standalone section of this report but rather woven throughout the report. This report appears to be an example of the PO training in program management that several
POs mentioned during the CoV.

Similarly, the 4th year site visit report and PO summary recommend that the review application include overall project management in terms of 1) A mission statement 2) a Theory of Change 3) a focused set of priorities and 4) projected outcomes and indicators and 5) explicit diversity goals.

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

In many cases, centers seem to be planned from a level above that of the DBI leadership or scientific staff, and it is therefore difficult to comment on their selection and responsiveness to emerging opportunities. A strategic process should be developed that includes bottom-up initiation from the community and from POs. It is also unclear how the budget, as a strategic tool, can be used to ensure the "right mix" and number of centers for catalyzing research, education, and their integration.

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

See response to #2.

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

There were many comments in last year's CoV report (summarized in italics hereafter) regarding the Centers Cluster.

● *Assessing synthesis centers. We recommend that DBI, perhaps in collaboration with SBE, lead the development of a robust process to assess the effectiveness of a synthesis center. The assessment should begin with a clear enunciation of the desired outcomes, and include the activities of training and outreach. This process should be used in evaluating current centers as well as in the design of new centers.*

It was not obvious from the materials available that an assessment for center evaluation was developed or used.

● *Managing synthesis centers. We recommend that DBI lead the development of a protocol by which each center is created and subsequently managed. The protocol should be assessed frequently and made transparent to the rest of the Directorate as well as the communities served by the Centers.*

From the conversations and available materials, it does not appear that this recommendation was fully addressed. While annual reports and site visits from Centers include discussion of project management, the precise role of the DBI in this process is unclear.

● *Merit review criteria not addressed in 24% of individual reviews.*

This has been significantly improved, no deficiencies noted, though individual reviews addressed just the 2 criteria (intellectual merit, broader impact) rather than the 9 included in the review summaries.

● *iPlant program would have benefitted considerably from more advice and oversight from DBI or BIO on the use of best management practices for large infrastructure programs.*

More PM training for POs should address this issue.

● *DBI needs to strategically consider its full portfolio of centers as parts of a critical "program". The division should more comprehensively consider ways to manage these centers by including PDs from DBI and from the other thematic directorates into a management team, thereby ensuring responsiveness to the communities served by the programs, enhancing communication within BIO, and optimizing professional experiences that can be applied to management of complex cooperative agreements.*

The CoV has observed exactly the same problems this year. There doesn't seem to be any improvement on this issue.

> ● *Last CoV thought centers were responsive to emerging opportunities through supplements.*
>
> This seems a limited way in which to be responsive.
>
> ● *Issues raised by the previous CoV were not addressed (e.g., Recommendation 1.4). To complement internal strategic planning at NSF, the CoV recommends that NSF undertake an external assessment and study (e.g., by the NAS) of these opportunities, and possibilities for synergy at all levels, within and across programs at DBI, BIO and NSF.*
>
> This was also not addressed in this period, so it has not been addressed for six years. Nonetheless, it is possible that the problems besetting the Centers Cluster can be solved without an NAS study.

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).*

OTHER TOPICS

It is worthwhile to have management of the centers centralized in DBI. This facilitate consolidation of knowledge about management practices and options regarding large and high visibility projects. As a case in point, NEON should provide an opportunity to demonstrate DBI's skills in this venue. Currently, NEON appears to be a distraction from other center efforts for DBI, but given the level of investment in NEON, this temporary situation is understandable. Judging from management of previous and current centers, there seems to be a pattern where very large projects struggle significantly in the early years. With insufficient management experience or training with regard to larger projects, program officers and support staff operate in a reactive and sometimes frenetic way to various issues that arise concerning project implementation and risk minimization (i.e., operating in "fire drill mode"). In part this may be attributed to the shifting management of such centers to DBI, as these projects were initially managed elsewhere. It would be helpful to understand programmatically how to get large projects off to a good start without creating large distractions for management. The centralization of management within DBI should aid in this process. Currently, some DBI staff

seem to feel that the centers projects simply appear, without sufficient input from them and without coordination with other DBI focus areas. The centers could perhaps have more impact if they tied in better with other DBI projects.

In conversations with POs outside of DBI, it became clear that the DBI infrastructure is very much appreciated by the other divisions in BIO. In conversations with POs within DBI it was not clear that this appreciation was transmitted as accurately it could be.

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

Planning for centers should be strategic and data driven. The process needs significant improvement. Identification of the nature of a balanced portfolio of centers should be considered as part of the budgeting of the Centers Cluster. More generally the DBI staff concerned with the management of centers appear to feel disconnected from decisions made in the BIO front office.

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.

It is not clear that centers are chosen to address program-specific goals, if by program-specific we mean DBI's goals. From what this CoV heard from POs, the placement of centers within DBI seems to be somewhat erratic, with the strategic or budgetary motivation unclear.

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

Directorate-wide issues are described in #1 and #2, but we see no agency-wide issues to be addressed.

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

None.

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

It was difficult to investigate the very many data points associated with centers in the limited time. Information about reports, CAs, reviews, MOUs was distributed. DBI staff did an outstanding job constructing an interface to this data, there is just an awful lot to click through in the very limited time when we are not interviewing NSF staff. Having more detailed assignments and instructions in advance would have helped tremendously.

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SIGNATURE BLOCK:

For the DBI CoV

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Chair