

**REPORT OF THE 7th EVALUATION
OF THE BIOTA-FAPESP PROGRAM
BY THE SCIENTIFIC ADVISORY COMMITTEE**

**3 to 11 July 2011
USP, São Carlos, SP. Brazil**

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NB. The BIOTA Program and the *BIOprospecTA* subprogram were evaluated separately and separate reports have been prepared. There are aspects, however, in both reports that have import to the other part of the Program and we urge that they be read in conjunction with each other and not simply as separate stand-alone reports. The two evaluation teams have held a number of joint discussions, and largely agree with the findings of the other team.

Overview

1. The Committee continues to be impressed by the BIOTA Program and by advances that continue to be made. The BIOTA program continues to provide an example, and sets standards, that many countries and other states within Brazil would be happy to follow.
2. The Committee was particularly impressed with the report that was presented on the *Institutional Impact Evaluation of the Biota Program / FAPESP*. It is apparent from that Survey that the decisions taken by the BIOTA Program to follow a Thematic approach has led to an increase in the overall productivity of the program when compared with similar FAPESP projects not included under the BIOTA umbrella.
3. Since the 6th Evaluation, the maps and books on conservation priorities produced from the program have been adopted by the State of São Paulo as the legal framework for biodiversity conservation policies. Indeed it was reported that 19 legal instruments (laws, decrees and regulations) had been adopted as a direct result of the BIOTA program and its outputs. These alone may be seen as more than justifying the establishment and continuance of the Program.
4. Since the 6th Evaluation, the Program completed its first decade and has developed the *Science Plan and Strategies for the next Decade*. The Committee has welcomed this report and are impressed by the depth and vision that document encompasses.
5. The BIOTA program made considerable progress since the last evaluation in a number of key areas – that of filling the gaps (many of which were identified in previous reports) and in integrating the results of the individual projects.
6. Output from the BIOTA Program has also continued to be impressive, with the Journal *Biota Neotropica* now publishing in the vicinity of 100 scientific papers per year and with the number of publications arising out of the Program increasing from around 800 to 1145 since the last evaluation. In particular we note the change in policy to allow targeted calls for projects, with two of the key gap areas identified in previous reports – Marine and Microbiology – being covered with such calls. This change of approach is welcomed by the Committee and we are pleased to see the response in the number of proposals that have been submitted. We understand that similar targeted calls were made for Biological Collections and for Taxonomy, Systematics and Phylogeography and we look forward to seeing the projects that arise from these calls.
7. During the meeting it became apparent that there are still problems with collectors obtaining licenses for collection. This is particularly so for bioprospecting projects. This issue was raised in the previous reports, and appears to still be an issue.
8. The adoption of the recommendations of previous evaluations committees by the Program have emphasized the importance the Program Coordinators place on this process. The Program appears to have benefited greatly from these evaluations and we strongly recommend that external evaluation be continued.
9. Finally, this committee would like to congratulate FAPESP and the BIOTA Coordinating Committee for the comprehensive way they have examined the 6th and previous reports and implemented many of the recommendations. As mentioned above, we note in particular the processes put in place to address the identified gaps in knowledge and the efforts to link to other State, Regional and International programs. This was evidenced by the associated meetings being held with the NSF in conjunction with the Evaluation meeting. Although a lot more effort needs to be expended in this area, the progress made to date is already showing benefits to the program.

Major Recommendations

- i. *FAPESP, the BIOTA Coordination Committee and the BIOprospecTA Coordination Committee recognize and further develop the shared concepts, goals, and strategies of BIOTA and BIOprospecTA.*
- ii. *The BIOTA Coordination Committee encourages the development of at least one major thematic grant on broad-scale biodiversity conservation across all biomes and geographic areas within the State using robust methodologies. We also encourage BIOTA Coordination Committee to consider bringing international expertise to this question and to explore associated links to CBD (Convention on Biological Diversity) targets, IPBES (International Platform on Biodiversity and Ecosystem Services), and other international initiatives.*
- iii. *In the new Themes of Microbial and Marine Diversity there is an opportunity for FAPESP to make a major investment in a new high-throughput DNA sequencing center in addition to its investment in the Alpha Curcis ship.*

Introduction

10. As part of its review and quality assurance policy the BIOTA-FAPESP Program has its achievements evaluated by a committee of independent experts. This report is the seventh evaluation by such a committee.
11. The evaluation took place in conjunction with the VII. Biota Symposium and the Fourth BIOprospecTA Program Assessment meeting in São Carlos attended by a large number of students. Nine mini-courses were also conducted.
12. As recommended in the previous evaluation report, the projects were presented to the Committee in a more thematic way with summaries provided of projects in each thematic group along with a summary of gaps, shortcomings, linkages and future goals. This approach, as well as being helpful in the evaluation, appeared to also be worthwhile in bringing related projects together to examine as a theme; shortfalls, gaps, conclusions, etc.

Methodology followed by the Evaluation Committee

13. The evaluation committee spent a brief period examining the BIOTA Program between July 3 and 11 during the VII Symposium of BIOTA and the associated Evaluation meetings. It established its opinion through:
 - attending oral presentations and poster sessions;
 - interviews held with BIOTA Program coordinators (Professor Roberto G.S. Berlink, Professor Carlos Alfredo Joly, Professor Luciano Verdade, Professor Mariana C. Oliveira, Dra Vanderlan Bolzani), as well as with project leaders, students and presenters at the symposium
 - presentations on the Biota+10 Program by Professor Joly and on the Institutional Impact Evaluation carried out by the Grup de Estudos sobre Organização da Pesquisa e da Inovação
 - document material, including a brief description of the current thematic projects
 - the document - *Science Plan and Strategies for the Next Decade*
 - previous evaluations of the Biota-FAPESP Program including the 6th Program Evaluation
 - Studying information offered via the Internet, especially the BIOTA website, Biota Neotropica, SinBIOTA, and associated web sites.
 - Using personal expertise of committee members and discussions with the evaluator of the BIOprospecTA subprogram, Professor Robert Verpoorte.
14. The Committee endorses the report of the sixth evaluation as it represents a comprehensive analysis of this program and we do not wish to repeat much of what is stated therein. We endorse the comments and recommendations it provides and respectfully suggest that this report be read in conjunction with it. We have reiterated some points, however, that we regard as continuing to be critical to the successful continuance of the BIOTA program.

General Issues

15. The committee noted the *Institutional Impact Evaluation of the Biota FAPESP* program carried out by the Grup de Estudos sobre Organização da Pesquisa e da Inovação and were impressed by the results of that evaluation. The Committee particularly noted the apparent increase in influence that appeared to be a result of the Thematic approach adopted by the BIOTA Program. The evaluation also reported a significant increase in the number of papers published, the number of PhD dissertations and the number of authors on papers as a result of the Thematic approach.
16. One thing of concern to the Committee in the Evaluation was that one of the key reasons (12%) given for other projects not joining the Biota Program was that they did not know of the project. Perhaps the cause of this lack of knowledge needs to be explored further.
17. Arising from that evaluation, the Committee believes it is important that the data from FAPESP projects that fall into other Thematic areas, but that have a biotic component, be captured by the BIOTA databases such as SinBIOTA. What the best approach is for this to happen needs to be explored by the Coordinating Committee along with FAPESP. At the very least, the Coordinators of those projects need to be encouraged to add their data to the BIOTA databases.
18. The 6th Evaluation report reinforced the need for a closer relationship between the BIOTA Program and the State and Federal environmental and development agencies in order to directly and quickly inform decision-makers and environmental managers about the Program's major findings and their implications for economic and development planning. The Committee notes the major advances that have been made in this area since that report and commends the Program on the initiatives that have taken place in this area.
19. The committee notes the change in policy that has allowed for the calling of projects targeted to address specific gaps in the program. We understand that there have been four such targeted calls for proposals, and already these appear to have been successful in bringing new groups of researchers into the Program. We commend FAPESP and the BIOTA Coordination on instituting this policy change and look forward to seeing the gains made in addressing some important gaps – many of which were identified in previous reports.

Sustainable Use

20. The Committee is pleased to note that the *Institutional Impact Evaluation of the Biota FAPESP* report concluded that BIOTA has made significant contributions in knowledge advancement (including publications, students), and made a significant increase of biological collections. Another welcome conclusion of the survey was that BIOTA has made significant contributions in biodiversity characterisation and conservation.
21. On the other hand, it is notable that the Survey concluded that contributions to “sustainable use” were still “incipient”. This conclusion logically follows from the fact that the BIOprospecTA process of exploration is in its early stages. There has been much success in identifying prospective useful compounds/products, but this has not yet progressed to actual uses. Of course, achieving “use” is just one step towards the core BIOTA requirement of “sustainable use”. A recommendation is that BIOTA consider how its research programs and future projects might explicitly address this important concept.
22. The Committee anticipates that this process would provide an opportunity to highlight links between BIOTA and BIOprospecTA. Current BIOprospecTA projects not only have had great success in identifying biologically active compounds, but also have successfully

adopted a strong phylogenetic perspective. This highlights how some species within a given taxonomic (phylogenetic) group may deliver evolutionary or “evo-system services” – corresponding to the potential benefits to human well-being from identified biologically active compounds. The phylogenetic perspective at the same time highlights how other, not yet studied, species may provide useful products in the future. With these perspectives in mind, we may consider how “sustainable use” amounts to a requirement that we keep our options open for future discovery of useful products in these other species. Thus, any true “sustainable use” encompasses not only current identified uses but also the sustained capacity to find other uses, in other species. A conclusion is that sustainable use goes beyond currently discovered uses – it also requires conservation of the evolutionary history of these taxonomic groups. Thus, BIOTA biodiversity conservation goals and BIOprospecTA discovery goals can be linked through the concept of sustainable use. The Committee recommends that the Science Plan might make these links explicit and use this as possible guidelines in developing more integrated projects (see also paragraph 53).

23. The Committee also notes that “sustainable use” also has other important dimensions. A key aspect is the conservation of varieties by establishing current value to humans. This is well exemplified by the current BIOTA project on nutritional and functional properties of non-conventional edible vegetables, which argues that traditional knowledge of these foods is gradually being lost but demonstrating the nutritional value is an important strategy for biodiversity conservation. Further, this conservation of genetic resources may provide other benefits.
24. The committee applauds the Science Plan’s position that conservation and economic development efforts should go hand in hand with drug discovery work, and suggests that a focus in future projects on the sustainable use theme will help achieve this.

Marine Biodiversity

25. The initial BIOTA program included some significant marine projects that documented distributions of higher animals on offshore islands and provided an inventory of invertebrates exposed in the littoral zone, but the immediacy of the needs for advice on effective land conservation planning took priority. Successes on land and potential new hazards at sea resulting from anticipated offshore drilling operations have shifted the balance toward the sea again in the planning for a BIOTA+10 Theme.

Specific goals identified include:

- a) spatial-temporal studies of mangroves, as a key ecosystem, and of other marine environments;
 - b) determine and monitor populations;
 - c) use data generated to improve biodiversity conservation policies;
 - d) identify endangered species, mapping their occurrence, status of the population and actions to reduce their extinction risk;
 - e) identify invasive species, monitoring their occurrence, expansion rate and implement control actions;
 - f) stimulate bioprospection of marine organisms, as a potential source of new lead-molecules of economic interest.
 - g) training of taxonomists for key taxa;
 - h) education and science outreach
26. Projects funded through 2012 range from determining energy yields from cultured microalgae through DNA barcodes for macroalgae, ultrastructural characters in shore crabs to population studies of jellyfish and squid which are among the few marine species that are increasing in

abundance, globally. There is also a project for bioprospection in groups with a history as drug sources and a major effort to move marine biodiversity into school curricula. A recent call for proposals will likely add about 10 more projects to this list focused on the other goals.

27. Over 50% of the State waters are already identified as protected areas, well above the 2020 goal set by the Convention on Biological Diversity (CBD), but much more effort is required to characterize the fauna and flora to determine if they really meet the criteria of being “representative”. It is also important to recognize that the dynamic nature of the ocean must be considered in relation to risks of oil impact on coastal biodiversity. While at least one of the current projects will use ocean current models to understand population dynamics in the nearshore, ultimately more rigorous models and even real-time observing capacity will likely be needed to predict and minimize impacts of oil spills. In addition to such short term concerns there is also growing concern about the long term capacity of the ocean ecosystem to maintain its ecosystem services for oxygen production (half of all the oxygen in the atmosphere) and as a carbon dioxide sink as climate change, ocean acidification and other kinds of pollutions continue to increase.
28. Projects to date do not deal with the vast diversity at risk in offshore waters and in bottom fauna. Some of the species here are already at risk from overfishing (e.g. turtles) and such risks will be compounded should an oil spill occur. A good biodiversity inventory, such as that available for the Gulf of Mexico, will be crucial to assess damage and monitor recovery. The fact that FAPESP has provided vessels for research at sea by the State universities is an encouraging sign that biodiversity research will be able to go beyond “ankle deep” in the future. It is also encouraging that the marine research group is aware of and already planning compatibility with the Intergovernmental Oceanographic Commission’s global Ocean Biogeographic Information System (OBIS) for their data.

Microbial Biodiversity

29. The original BIOTA program had a very limited emphasis on microbial biodiversity, but there has been a technical revolution in this field in the last few years that has allowed BIOTA+10 to develop it as an important new focus. Historically, microbial species were only recognized if they could be maintain in isolated cultures, but high-throughput DNA sequencing technology has made it clear that there are at least 100 times as many types of microbes as can be cultured. One explanation may be that genetically distinct microbes can survive in a kind of symbiosis by providing enzymes that carry out complementary processes. Such microbes obviously cannot be maintained in pure cultures, but can be shown to be distinct “operational taxonomic units” (OTUs) that maintain unique genetic characteristics. Goals for this new theme are both short- and long-term:

Short-

- a) inventory of the microbial diversity in the areas being studied in the BIOTA program
- b) database of physical attributes of the ecosystems being studied in the BIOTA program
- c) integration of different databases

Long-

- a) ecosystem functioning: Metagenomics, Metatranscriptomics, Metaproteomics and Meta-metabolomics
- b) microbial physiology: reconstruction of metabolic pathways
- c) microbial ecology: microbiome characterization and evolution
- d) prospection of compounds of biotechnological interest
- e) management of the microbiota for helping ecosystem restoration

30. The two currently funded projects in this field include both cataloging and bioprospecting elements for the mangroves and the Atlantic Forest. In the case of mangroves there is also an overlap with the Marine Theme. Further expansion of this Microbiology Theme is expected as 46 new proposals are reviewed and potentially funded. These projects all appear to be moving in sensible directions.
31. Both the current investigators and the Scientific Advisory Committee recognized a serious limitation and an opportunity in this field. In part because of this revolution, high-throughput DNA sequencing technologies rapidly improving and costs decreasing. FAPESP has the chance to get ahead of the technology curve by using this Theme to justify a new facility that will avoid sending material outside SP for processing. There are two reasons this is important: first, it keeps money at home and, second, it avoids the added complexities and wasted time required for exporting biological materials. Such a facility would assure rapid advances in many BIOTA+10 projects and could make SP a center for such technology in Brazil. We should be clear that such a center would not be a one time commitment, as this technology will rapidly improve and demand will grow.
32. Maximizing the bioprospecting value of microbial research really has two components now:
 - a) maintaining frozen cultures of organisms that can be screened by companies for particular metabolites and
 - b) maintain massive DNA libraries for organisms that cannot be cultured but may have DNA sequences with unique properties that can be reproduced in other microbial systems. The center suggested above might also have a role to play in these requirements as well.
33. The current BIOTA project “Microbial diversity in the phyllosphere and soil of the Atlantic Forest” provides a good example of the remarkable levels of diversity to be discovered by the new molecular and analytical methods. The project also highlights a key theme in the emerging literature on microbial ecology: the composition of microbial communities changes from sample to sample (or place to place) in predictable ways (often summarised through habitat variables or environmental gradients). These explanatory models can be extended to predict spatial patterns of turnover in microbial communities. Key biodiversity indices including endemism indices can be calculated. GEO BON is investigating these models as part of the “lens” strategy to track regional changes in the status of biodiversity activities. In this approach, remote sensing or other information on changes in land/water condition is interpreted through the biodiversity “lens”, enabling inferences about the amount of biodiversity loss (see http://www.earthobservations.com/documents/cop/bi_geobon/200811_geobon_concept_document.pdf).
34. It is noteworthy that the same analysis toolbox commonly used for species and community distribution models and conservation evaluation can be used for the microbial analyses. This provides another opportunity for integration across BIOTA projects: single species data, microbial and other genomics data, and DNA barcoding data can all be integrated into regional biodiversity assessments and conservation planning. The committee recommends that these integrative strategies be considered as a way to link projects and databases.

Taxonomy and Inventory

35. The Committee noted that there appeared to be a number of significant gaps in coverage in the program, both environmentally and taxonomically. Many of the geographic gaps appear to have been already identified and mapped from the SinBIOTA and speciesLINK databases, however reports of the number of taxa in each group in the databases appeared to concentrate on higher taxa (vertebrates and vascular plants) so the committee is unaware of gaps that may exist in other groups, for example arthropods and other invertebrates including the marine invertebrates.
36. We suggest that both environmental and taxonomic Gap Analyses may need to be conducted to identify what gaps do exist and to help determine where future targeted calls for projects may be concentrated.
37. One of the important CBD targets is Target 19 – “Biodiversity knowledge improvement and transfer” the target requires that, by 2020, “knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied”. One of the nominated indicators for Target 19 is the number of new species described. The Committee notes that Brazil’s approximately 200,000 described species is a small fraction of the estimated total of 1.8 million. The knowledge gaps are even greater when considering the need for geo-referenced data for biodiversity conservation planning and management.

Biodiversity Conservation

38. The *Institutional Impact Evaluation of the Biota-FAPESP* considered innovation as linked to creativity and “social appropriation”, and therefore looked for BIOTA outputs used in public policy. The Committee notes that a high 39 of 85 outputs became “innovation” in this sense. The Committee recommends that future BIOTA projects further develop public policy links, and suggests that one pathway can be through a focus on CBD and other biodiversity policy contexts. These policy links also could help provide integration of various BIOTA projects.
39. The *Science Plan* properly highlights, in its Introduction, how the Convention on Biological Diversity (CBD) provides important context for BIOTA. The twenty ‘Aichi targets’ defined by the CBD for the period 2011–2020 are to be addressed through a “flexible” framework, where each country or region devises its own strategies. The Committee recommends consideration of the challenges posed by these targets; they suggest guidelines for future projects and point to opportunities for BIOTA to provide world-leading biodiversity conservation outputs.
40. A key CBD target is Target 11 which calls for protection of 10% of marine area. An important condition on this target is that the protected areas are to be representative of the regional biodiversity. The committee feels that future BIOTA projects should address this issue. Strategies will include the effective use of existing (and new) data to build robust biodiversity surrogates for the marine realm (surrogates models use existing data to talk about more general biodiversity patterns). The Committee notes that no current marine projects have biodiversity conservation policy links or objectives.
41. The development of biodiversity surrogate models to assess representativeness provides other benefits. The same models could be used for survey design (deciding where to sample to have the best chance to find new species). The models could also be used to implement the “lens” approach advocated by GEO BON to enable ongoing biodiversity monitoring in a given region. (see

http://www.earthobservations.com/documents/cop/bi_geobon/200811_geobon_concept_document.pdf).

42. Such a program would help to satisfy the high priority objective for the next decade, stated in the Science Plan for BIOTA+10, “to produce estimates about biodiversity loss” for the region. Estimates that truly reflect overall, wholesale, biodiversity will have to rely on such surrogates models. The committee notes that BIOTA objectives include the use of species distribution models and some of the advanced community level methods. This would synergise well with the methods being taken-up within GEO BON for the lens type strategies.
43. The committee notes that biodiversity models for SP could establish and build on links to programs that are providing large scaling modelling of species distributions (for example Map of Life).
44. Another target of particular relevance to BIOTA is Target 5 which calls for significant reduction, by 2020, in the rate of degradation and fragmentation. A range of models should be considered to estimate biodiversity loss due to fragmentation. For example, the size of fragments can be linked to fraction of species persisting.
45. The Committee notes that the related Strategic goal D for the CBD 2020 targets calls for efforts to enhance delivery of ecosystem services through restoration of degraded systems. This can provide an important rationale for systematic, regional restoration efforts in SP. The committee notes the key BIOTA objective for restoration of native ecosystem in SP, and fully agrees with the shift in Program name:

“The need to implement a biodiversity restoration program in the State of Sao Paulo is so urgent, that it justifies changing the name of the BIOTA/FAPESP Program to “Research Program on Biodiversity characterization, conservation, restoration and sustainable use”.
46. The Committee recommends development and application of indicators of degree of improvement in ecosystem services and biodiversity representation and persistence, as a consequence of restoration activities. The Committee suggests that a future project could design and implement a critical test of the hypothesis that increased connectivity will benefit one or more species and/or ecosystem services.
47. The Committee recommends that BIOTA continue to integrate SP restoration planning into broader conservation development planning.
48. The Committee notes the projections that sugarcane will expand from 9 to 14 mill ha by 2016 and eucalyptus from 6 to 16 mill ha by 2020. These scenarios suggest that BIOTA projects may need to assess changes in representativeness of intact lands in the region (recall previous recommendation for an overarching biodiversity conservation project). Scenarios analyses may be useful for examining alternative spatial patterns for these changes. Such scenario analyses importantly will allow progression beyond the static mapping of priority areas to dynamic planning where priorities are re-assessed in light of land condition changes and/or scenarios of change.
49. Future projects might also attempt to quantify the biodiversity values retained in such human-altered landscapes, and integrate these contributions into the overall regional “report card” for biodiversity representation and persistence.
50. The Science Plan noted that the Atlantic Forest and Cerrado have been reduced to 12% and 2% of their original areas, and noted the likely high degree of endemism in these areas across various taxonomic groups. A priority may be to use available and new inventory data to estimate remaining intact areas of endemism in the region.
51. Other targets, including Target 6 and 7 on sustainable exploitation of marine and terrestrial resources, and the targets on conservation of threatened species also should be considered in

defining priorities for future BIOTA projects (noting that there are approximately 8500 known threatened species in the neo tropics).

IPBES

52. The emerging ‘Intergovernmental Platform on Biodiversity and Ecosystem Services’ (IPBES) will be an interface between the scientific community and policy makers. IPBES aims to build capacity for and strengthen the use of science in policy making. IPBES is to “perform regular and timely assessments of knowledge on biodiversity and ecosystem services and their interlinkages, which should include comprehensive global, regional and, as necessary, sub-regional assessments”. IPBES is to achieve its goals through collaboration with existing initiatives on biodiversity and ecosystem services. The Committee recommends that future BIOTA project planning consider opportunities to feed into the IPBES process, both through the capacity building theme and regional assessment.

DIMENSIONS OF BIODIVERSITY

53. The U.S. National Science Foundation’s Dimensions of Biodiversity campaign provides research funding at the interface of taxonomy, function, and genetics. It is anticipated that the international collaborations will include programs with Brazil. The Committee recommends that BIOTA examine the opportunities for such collaborative projects, and could consider building on the phylogenetic themes that underlie sustainable use (see paragraph 22).

Databasing and Infrastructure

53. The BIOTA program has a number of databases that have arisen from the Program and that are key to it. The SinBIOTA database is in the process of being migrated from the Centro de Referência em Informação Ambiental (CRIA) to the University of Campinas (UNICAMP), and at the same time is being upgraded and refined. It appears that this process will largely be seamless to the user, although it is apparent that there has been a drop-off in accessions into the database in recent years due to many new projects not fitting easily into the structure or for a number of other reasons. The SinBIOTA 2.0 prototype is well advanced and is at the stage where data is about to be transferred to it. It is important that the new version of the database reflect fully the users’ needs and that any developments be carried out with those needs firmly in mind. The Committee believes that this is being done, and that the developers will shortly be visiting many of the BIOTA projects to talk to the researchers. This will be particularly important for the new Theme projects such as Marine and Microbiology.
54. It was apparent from discussions during the meetings that the link between the various BIOTA databases is important and should not be neglected. Where linkages already exist, such as between SinBIOTA and speciesLINK, these links should be enhanced and strengthened, and where they currently don’t exist – such as between SinBIOTA and the BIOprospecTA databases that they be developed. In particular, current linkages between the SinBIOTA database and the speciesLINK database that have existed while the two databases have been managed by CRIA should not lessen as a result of the transfer of SinBIOTA to UNICAMP. As mentioned in the BIOprospecTA evaluation, it is important for many reasons that the BIOprospecTA database be linked to the SinBIOTA database so that information in one can be used to the benefit of the projects in the other and to benefit the Program as a whole. It is also important that the redeveloped SinBIOTA database be able to handle large numbers of sequence information. This will be important for helping to determine priorities for Biopropection as well as for taxonomy in such groups as microbes.
55. It is important that databases under the BIOTA program such as SinBIOTA 2.0 be strongly integrated with external databases such as GBIF (Global Biodiversity Information Facility),

OBIS, Species2000 and others. Integration with these and other external databases would assist the Program in a number of ways. Examples that readily come to mind are the additional data that can be incorporated from institutions and agencies outside Brazil and the supply of key information (such as species names) that can assist in improving the quality control processes of the database.

56. The *Institutional Impact Evaluation* survey identified a number of projects that were biodiversity-related, but which fell in other Theme areas of FAPESP. Even though these projects do not fall under the BIOTA umbrella, it is important that the data arising from these projects, where possible, be incorporated into the SinBIOTA database.

Education and Outreach

57. A number of participants and projects brought up the need for a greater effort to be spent on the outreach aspects of the Program, and especially the outreach to educational institutions and teachers. The Committee sees many areas where outreach could be enhanced – not only to teachers, educators and students, but to environmental managers, farmers, policy makers, journalists, interested naturalists and the general public.
58. The issue of Citizen Science and the contributions that non-scientists can make to the biodiversity knowledge base was raised by a number of participants. As more outreach and education material reaches the public (e.g. handbooks, field guides etc.) it is likely that members of the public will be interested in contributing. One area where this can be easily implemented is through images. Digital cameras are becoming more common, and it is becoming easy to take an image, georeference it using Google Earth or Yahoo maps, etc. and to make the images available on the Internet. This process should be encouraged and coordinated in ways similar to that being done by the *Encyclopedia of Life* and the *Atlas of Living Australia* through the resources of Flickr (<http://www.flickr.com>). Indeed, the resources are already available and it requires very little effort to hook into existing processes. One requirement, however, may be that people be required to begin using such things as Creative Commons licensing (see <http://www.creativecommons.org.br/>) which allows images to be made freely available (with attribution) for non-commercial purposes.
59. Mention was made during the discussions that there was a need for some form of coordinated output in the form of a Journal, series of linked publications and educational material that clearly identified the BIOTA Program and that would be a resource for science teachers, other educators, park managers, farmers and others to use. This would provide a means for the BIOTA Program to link its research outcomes to education and outreach. These might include anything from one-page information sheets on individual species (both on-line and in hard copy) through to field guides, posters and handbooks, guides to farmers (for example on pollination, conservation of crop wild relatives, etc.). It would be a parallel output to the journal *Biota Neotropica*.

Recommendations

- i. *The Committee recommends that the BIOTA biodiversity conservation goals and BIOprospecTA discovery goals be linked through the concept of sustainable use. The Committee recommends that the Science Plan make these links explicit and use this as a possible guideline in developing more integrated projects.*
- ii. *We encourage FAPESP to ensure that the new BIOTA marine Themes and other biodiversity projects are ensured equal access to its new ship, Alpha Crucis. There are many potentially serious societal side-effects associated with marine impacts on biodiversity. We also emphasize that real-time ocean monitoring can contribute to mitigation of biodiversity loss in marine systems.*
- iii. *We encourage FAPESP to invest in a center in SP for high-throughput DNA sequencing, recognizing its importance for many new ways of documenting and recording biodiversity. Such a center could also facilitate various types of commercial bioprospecting as discussed above.*
- iv. *That once the SinBIOTA database redevelopment has reached a mature state that the BIOTA Coordinating Committee consider conducting Gap Analyses (both taxonomically and environmentally) and use the results to help determine priority areas for future targeted calls for projects.*
- v. *The Committee recommends that Target 19 of the CBD be used as a rationale for future increased efforts to extend the knowledge base of species and their geographic distributions within the State of São Paulo.*
- vi. *The Committee recommends that future BIOTA projects further develop public policy links, and suggests that one pathway can be through a focus on CBD and other biodiversity policy contexts. These policy links also could help provide integration of various BIOTA projects.*
- vii. *The Committee recommends consideration of the challenges posed by these targets; they suggest guidelines for future projects and point to opportunities for BIOTA to provide world-leading biodiversity conservation outputs.*
- viii. *That future BIOTA projects address representativeness. Strategies will include the effective use of existing (and new) data to build robust biodiversity surrogates for the marine realm.*
- ix. *The Committee recommends that BIOTA explores the use of biodiversity surrogate models for implementing the “lens” approach of GEO BON to quantify ongoing biodiversity loss.*
- x. *The Committee recommends development and application of indicators of degree of improvement in ecosystem services and biodiversity representation and persistence, as a consequence of restoration activities. The Committee further suggests that a future project could design and implement a critical test of the hypothesis that increased connectivity will benefit one or more species and/or ecosystem services.*

- xi. The Committee recommends that BIOTA continue to integrate restoration planning into broader conservation and development planning within the State of São Paulo.*
- xii. The Committee suggests that future projects attempt to quantify the biodiversity values retained in human-altered landscapes, and integrate these contributions into the overall regional biodiversity “report card”.*
- xiii. The Committee recommends that future BIOTA project planning consider opportunities to feed into the IPBES process, both through the capacity building theme and regional assessment.*
- xiv. The Committee recommends that the BIOTA Coordination Committee ensure that current linkages between the SinBIOTA and speciesLINK databases be maintained on transfer of the SinBIOTA database and where possible be enhanced, and that linkages between the SinBIOTA 2.0 database and the BIOprospecTA database be developed.*
- xv. That the SinBIOTA database be designed in a way that it can accept what are likely to be very large numbers of sequences, especially from microbes.*
- xvi. That enhanced integration between SinBIOTA 2.0 and external databases such as GBIF, OBIS, etc. be given a high priority.*
- xvii. That FAPESP projects that have a biotic component but that are funded other than through the BIOTA Program, be encouraged to incorporate the data and outputs of their research into the SinBIOTA database to streamline state, national and global linkages.*
- xviii. That the Coordination Committee examine the opportunities available for enhancing the project through the use of Citizen Science, Creative Commons Licensing and Flickr. This may best be done in conjunction with the redevelopment of the SinBIOTA database.*
- xix. That the BIOTA Coordination Committee give consideration to establishing an outlet for the education and outreach parts of the Program in the form of linked set of publications that may be both electronic and available through the World Wide Web and in hard copy where appropriate.*
- xx. That the BIOTA Coordination Committee examine the opportunities for collaborations with the U.S. National Science Foundation’s Dimensions of Biodiversity campaign, for example, by building on the phylogenetic themes that underlie sustainable use.*