

# **The Role of Biological Field Stations in Education and Recruitment into the Biological Sciences**

## **Report of a Workshop, “Education and Recruitment into the Biological Sciences: Potential Role of Field Station and Marine Laboratories”, Washington, D.C.**

**February 11-12, 2002**

Michael J. Klug, W. K. Kellogg Biological Station,  
Michigan State University, Hickory Corners MI

Janet Hodder, Oregon Institute of Marine Biology,  
University of Oregon, Charleston OR

Hilary Swain, Archbold Field Station, Lake Placid FL

This report was prepared by the workshop participants. The workshop was supported by the National Science Foundation through Grant No. DBI-0208229 to Michigan State University. Any opinions, findings, conclusions or recommendations expressed in the report are those of the participants, and do not necessarily represent the official views, opinion or policy of the National Science Foundation.

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#### I. Introduction

Human impact on biological functions over the past century is unprecedented and the need to understand this impact has never been greater. This need can only be satisfied by an increased penetration of scientific knowledge into all sectors of society. Various sectors of society use and develop natural landscapes without understanding the human impact on these systems. Awareness of the complexity and services provided by these systems needs to be instilled at an early age and continue over a lifetime. Education in these areas can be enhanced through field based educational programs and experiences. Field experiences provide a venue for the actual conduct of science and experiencing inquiry-based learning in all types of biology. The challenge is to provide opportunities to experience field biology to all sectors of society including those concentrated in urban settings.

Within the scientific community, research challenges are increasingly those associated with higher orders of biological interactions involving integrative and interdisciplinary questions. Continuous recruitment of scientists into biological and environmental sciences is required to sustain and enhance these levels of research. During their K-12 and undergraduate careers students need exposure to the complexity of field studies to develop and refine interests in continuing their interests and studies in these directions. Students that go onto careers in other disciplines also benefit from FSML type experiences because they bring the perspective of interdisciplinary problem solving in complex systems to these other disciplines.

Biological field stations and marine laboratories (FSMLs) are recognized as a national resource for environmental and biological research and educational activities. A basic feature of all FSMLs is the synergistic interaction between research and education (Lohr et al., 1995). The permanent staff, visiting scientists, and scientific networks at FSMLs hold a tremendous depth of knowledge about local ecosystems and organisms providing an atmosphere conducive to scholarship and learning that can't be matched in any other setting. They serve as a gateway into the complexity of biological sciences. FSMLs are to the study of higher-order biological systems what research and teaching hospitals are to the medical sciences. In spite of their varying size, location, mission and sponsorship, the majority support and have the capacity to expand their educational programming. There are also two well-developed organizations which provide mechanisms for sharing successful models of program development, learning, and recruitment. The Organization of Biological Field Stations (OBFS) has a membership of 196 institutions, and the National Association of Marine Laboratories (NAML) has a membership of 126 organizations.

A workshop was held at the NSF (February 11-12, 2002) and participants were charged with examining the role of FSMLs in enhancing educational opportunities.

The primary goals of the workshop were to:

1. Explore educational opportunities which capitalize on the unique learning environment of FSMLs
2. Explore the role that FSMLs can play in enhancing recruitment into the biological sciences.

Working sessions explored the topics of facilitating field based experiences for three groups:

- A. K-12 students and teachers
- B. Undergraduates
- C. Community and continuing education individuals

A common discussion for each working session was an exploration of ways to increase the diversity of the participants within all forms of educational programming at FSMLs. Each session also had a discussion centered on the need for an evaluation component to educational efforts.

For each group workshop participants discussed:

1. The current conditions at FSMLs.
2. The challenges and barriers to greater participation by the educational group.
3. Strategies that FSMLs could undertake to enhance participation and increase the diversity of participants.
4. Research and evaluation needs.
5. Recommendations for the FSML community and for the NSF.

## II. The Role OF FSMLs in Facilitating Field-Based Experiences for all Sectors of Society

### A. K-12 STUDENTS AND TEACHERS

The importance of an early exposure to a field experience is emphasized by the understanding that if a child has not had a positive experience in the field by age 8 or 9 that they will have little interest in the environment in later life (Pyle, 2001). These early experiences are often through family or school activities. In the case of school activities field experiences are most meaningful if they are part of, or linked to, a student's science curriculum rather than an isolated "field trip". In this manner the field experience can be integrated with classroom activities. Successful linkage however often requires that teachers also have had previous exposure to field experiences, which often is not the case. Field experiences can also have a positive influence on heightening students' interest in science and serve as an entry point to considering a career in science. Many researchers in the field biological sciences point to early field exposure as being the life changing experience, which lead to their continued interest in science.

FSML facilities and their staffs are excellent resources for providing field experiences for students and their teachers. They provide access to field sites along with knowledge of how to use them for research and learning. The research expertise embodied by the FSML staff and scientists is readily applicable to inquiry-based teaching and often covers subject material that is translatable and of innate interest to teachers and their students. It is not difficult for students, teachers, and FSML researchers to be equally engaged in an active learning experience.

#### 1. CURRENT CONDITIONS AT FSMLs

The extent of K-12 programs at FSMLs is not well documented, however in a survey conducted in 1995, 36% (N=77) reported that they conduct K-12 programs (Lohr, 1995). An informal survey conducted at the 1998 annual OBFS meeting indicated that 71.4% (N=42) had K-12 programs. These programs range from intense consistent programming to occasional visits to FSMLs. In general, information on programs is not well synthesized or documented, and additional data are needed on the extent of all education programs at FSMLs.

#### 2. CHALLENGES FOR K-12 EDUCATION

Approaches for the K-12 audience must consider that each school system is faced with many different challenges in providing field experiences for students and their teachers. Likewise each FSML is faced with varying challenges to provide experiences for the K-12 system. In proposing programs we must consider barriers facing both schools and FSMLs.

##### i. FSML-based Institutional Barriers

- Lack of adequate education leadership and coordination in K-12 education at FSMLs.
- FSML-scientists fear of K-12 audiences compromising their research sites.
- Programs must ensure the continued integrity of the site.
- Lack of facilities at FSMLs to accommodate large group activities. Scale of programs need to be based on the total carrying capacity of the site, e.g., staff, facilities, and field sites.

#### ii. FSML Faculty/Staff-based Barriers

- Research faculty and FSML staff are often unfamiliar with educational needs of K-12 audiences and have limited experience in working with these audiences.  
Lack of research scientist's time and institutional rewards for non-research, non-university teaching activities.
- Difficulties for FSMLs in developing relationships with Colleges of Education faculty or other science educators. Cultural differences between research and education faculty reduce probability for interaction, collaborative grant efforts, and cooperation.

#### iii. K-12 System Institutional Barriers

- K-12 teachers are often intimidated by their lack of knowledge about the "field" and by science faculty. Teachers and FSML faculty have few opportunities to interact, and discuss ways in which they could work together.
- Urban teachers and students often have a fear of going into the field since it can be an environment quite foreign from that to which they are exposed to in their daily lives.
- Teachers often feel overloaded and need help to determine how they would interface a field experience with their required curriculum.
- Cost of and bus scheduling difficulties result in little monetary or time flexibility for conduct of field experiences.

### 3. Recommended Strategies for FSMLs FOR K – 12 AUDIENCES

FSMLs need to define their commitment and capacity to facilitate K-12 programs without compromising their staff, faculty, research sites, and other functions carried out within their facilities. Not all FSMLs will be able to support all scales of activities and the type of activities at FSMLs will be diverse. They can involve programs designed only for teachers or only for students, or in combination of both. They can be based either at a FSML, or at the school site, or a combination of both.

- For FSMLs that decide to develop strong K-12 programs the need for a well-trained educational coordinator is paramount. Strategies for shared coordination between consortia of FSMLs should also be considered.

- Few FSML faculty have the time or experience to become leaders in the K-12 education field. They do, however, have the expertise to provide relevant content for these experiences. Many faculty will participate in K-12 education programs if their time commitment can be minimized through adequate preparation and coordination provided by an education coordinator. Education coordinators can facilitate activities that fulfill the outreach component of many NSF disciplinary grants, thus assisting faculty to be successful in these endeavors.
- Engaging graduate students (e.g. via the NSF Graduate Teaching Fellows in K-12 education) and post-doctoral researchers in K-12 programs is recommended since it will provide them with experience teaching and an opportunity to learn about the challenges facing teachers. These interactions potentially lead to their continued future involvement with K-12 schools. Students are also often more comfortable working with someone closer to their own age.
- The link between science content and pedagogy is a significant need at all levels of science education. Linking research faculty and FSML education coordinators with college of education faculty or science educators will be important in order to integrate field experiences into curricular material and to have faculty presentations conform to appropriate pedagogy. The historic schism between scientists and science educators continues to be a barrier to reform in science education. The FSML environment has proved to be a formative setting for programs in which to break the barrier, e.g., as in the NSF DUE funded Faculty Institutes for Reforming Science Teaching project. Removing this barrier will require significant leadership and dialogue, by both parties, to bring these two groups together.
- Two mechanisms seem to have the most potential for connecting teachers with FSML research and thus preparing them to incorporate field activities into their classes:
  1. The provision of teacher professional development opportunities.  
Working with teachers and curriculum specialists in the schools in developing direct (FSML experience) or indirect (e.g. school yard or distance learning) field experiences which integrate into the existing curriculum and meet district, state, and national science standards will lead to programs that will reach a large number of students. The types of programs developed will depend upon the needs of each school district but would likely include school or FSML-based workshops for teachers, content and pedagogy courses held at FSMLs to cross-walk curricula material with FSML experiences, or longer intensive professional development programs. This engagement with teachers is important if field experiences of any sort are going to become a sustained part of a school's science curriculum. Several FSMLs already have these types of partnerships and useful insights into the complexities of initiating partnerships with schools can be found in McKeown (2003).
  2. The engagement of teachers in research.  
Individual teachers who have an emerging or all ready developed interest in facilitating

field experiences should be identified and encouraged to pursue that interest. Several mechanisms for such involvement are possible including participation in intense field courses that are characteristic of FSMLs, the opportunity to conduct their own research, and their inclusion in research activities already underway. Several NSF programs facilitate these opportunities. For example, the NSF Research Experience for Teachers (RET) provides an opportunity for teachers to do their own research at FSMLs. This research should also provide increased opportunities for scientists and teachers to work together in developing curricular material with activities related to research in ecological and field biology.

- For programs that focus on direct interactions with students at FSMLs it is suggested that multiple approaches be considered. These approaches include short initial exposures at the elementary level through more intensive experiential experiences at the middle and high school level. In this manner, program effectiveness can be tracked over time through an opportunity for using repeated measures.
- The location of a field experience for K-12 students need not be at a FSML. Logistical difficulties and costs of field experiences can be reduced through experiences in or adjacent to schoolyards carried out by teachers or FSML personnel. Where appropriate this learning can be reinforced through visits to FSMLs that expand on a student's experiences through interactions with research faculty at the field site. Schoolyard experiences can be less intimidating as the first experiences in the environment for urban school students. After school programs held in the school yard or at a FSML could be an additional way to give students field experiences. The use of distance learning does not replace field experiences, however they can reinforce and sustain students' or teachers' experiences in the field. Unconnected exposures to natural phenomenon, however attractive on television, are of much less use in the classroom. Students who have made a connection with some aspect of field biology through a visit to the field could use web-based materials to expand the impact of their field visit. For example, video observations of changes in plant phenology, or the availability of remotely sensed data, e.g., temperature, can lead to longer term projects associated with an initial FSML activity. It is suggested that there is coordination between education efforts currently underway in the LTER program and FSML program development in this area.

#### 4. Research and Evaluation Needs FOR K – 12 AUDIENCES:

Some research, and a great deal of anecdotal evidence, points to the importance of exposure to field biology at the K-12 level as a mechanism for developing and retaining an interest in biology.

Documentation of FSML use by K-12 audiences is incomplete, and there is no standardized instrument to assess the value of field experiences to school age children. Information of this nature will provide a measure of the real impact of experiences at FSMLs that can be used to address questions such as the following:

- Do field experiences increase scientific literacy? Are students better able to synthesize across disciplinary levels?
- Does K-12 student participation in field experiences lead to an increased likelihood of pursuing a science degree?
- Do the attitudes of K-12 students about science and biological issues change as a result of field experiences? Do students respond differently to questions related to environmental issues?
- What are effective mechanisms for encouraging people to study field biology?
- How does the learning gained at a FSML compare to that gained at nature or environmental centers?

## 5. Recommendations for NSF FOR K – 12 AUDIENCES

- There is little quantitative data available on K-12 programs at FSMLs. Before their full potential can be assessed, it will require a detailed survey of all educational programs at FSMLs.
- There needs to be a concerted effort to gather information to determine what types of FSML K-12 activities are most effective. This could be accomplished by the development of common evaluation instruments that can be applied across all FSMLs.
- This assessment and development of an evaluation instrument could be facilitated through the existing infrastructure of the OBFS and NAML with the help of the NSF.
- A major barrier to enhancing education programs at FSMLs is the lack of well-trained educational staff. It is recommended that NSF consider a competition for funding of education programs and coordination at FSMLs. Any program competition should include a long-term evaluation in order to fully measure the impact of an educational experience at a FSML.
- Expansion of the planning grant use guidelines in the NSF FSML infrastructure and facilities program would allow FSMLs to focus a planning grant on initiating partnerships needed to develop and implement successful K – 12 programs.
- Several existing programs at NSF that have the potential to support K-12 activities based at FSMLs including RET and the G K-12 program. NSF should consider refinements in these programs to encourage participation by FSMLs school districts and teacher partnerships. Programs such as Teachers Experiencing the Arctic and Antarctica or the Teacher at Sea concept serve as models for developing similar programs where teachers spend time at a FSML.
- The NSF-EHR Informal Science Education program guidelines are very broad and provide opportunities for education programs at FSMLs. It is recommended that DEB and EHR consider a special competition for FSMLs and LTER sites to develop education programs that support education reform and focus on inquiry based natural science.

- Financial constraints within educational systems often preclude opportunities for field experience for students in K-12 programs. The use of distance learning technologies to bring “field experiences” to classrooms does not replace an experience in the field, however it could provide a service, especially if these “experiences” were linked to research at FSMLs and to the curriculum presented in the classroom. In this manner the experience is linked to research and a career in science, not on unconnected exposures to a natural phenomenon. The uses of web-based live experiences and/or access to on-line sensor data are examples of these technologies. NSF could provide resources to apply web-based technologies for K-12 education.

## B. Undergraduate EDUCATION

Although the data are sparse, anecdotally we know that experiences associated with a college field course or research experience are life-changing events for many undergraduates. In addition, a critical element in retaining undergraduate and graduate students in biology is having a personal relationship and mentoring experience with a scientist. FSMLs bring faculty and students together in a community environment that is conducive to learning how science is conducted, and can allow for much more intensive mentoring than is often possible in the traditional University setting. These field experiences provide a venue for actually doing science, and experiencing inquiry-based learning in all types of biology not just traditional field-based topics. Such an experience can foster collaborative interdisciplinary approaches to research and learning, and provide students with training on working in interdisciplinary settings.

### 1. CURRENT STATUS AT FSMLs

The OBFS web site ([www.obfs.org](http://www.obfs.org)) provides a listing of courses offered at OBFS member stations and NAML does the same for its members ([www.naml.org](http://www.naml.org)). In a 1995 OBFS survey (Lohr, et al. 1995), 58% (N=77) of FSMLs reported offering formal courses for undergraduates, primarily during the summer. The courses range from disciplinary courses to those emphasizing methods and research experimental design. Information is scant on how these courses are related to campus-based courses, or how they are tied to existing curricula.

Undergraduate research opportunities are common at FSMLs. They range from individual faculty sponsoring students who undertake research to fulfill credits to students receiving stipend from faculty grants, REU programs, or other funding agencies. Ten FSMLs are currently funded as REU sites and numerous REU supplement awards are funded to researchers working at FSMLs.

### 2. CHALLENGES FOR UNDERGRADUATE EDUCATION

The challenge we face is how to ensure undergraduate students have opportunities to experience field biology, and by doing so, become aware of the possibilities of this type of experience both for personal learning goals, and for career possibilities. We suggest a strategy based on multiple scales ranging from encouraging short field experiences in freshman and sophomore introductory courses through intense semester/year long programs that include course work and research for undergraduates. An overriding

theme of the workshop's discussion was that the diversity of field opportunities means that no one program will fit all campuses/FSMLs and that consideration would be given to providing multiple ways in which undergraduates can be encouraged to participate in field biology. Just as FSMLs are diverse so should be the programs they offer.

In planning programs to increase field biology programs one needs to consider what barriers there are for students and faculty participation in such programs

#### i. FSML-based Institutional Barriers

- Because of traditional emphasis on research many FSMLs lack staff to support educational programs.
- In some instances there are insufficient facility resources at field stations to accommodate greater numbers of students.

#### ii. Faculty/Staff-based Barriers

- Community college faculty, who often teach introductory biology courses, are rarely associated with a FSML. In many instances these faculty are part time, and cannot afford to plan and include time consuming field experience in their courses.
- Logistics and funding often exclude field experiences in courses offered on main campuses
- There is a decreasing number of faculty in biology departments with field experience.
- Time and tenure constraints and lack of reward for teaching can preclude faculty from considering teaching intense field courses.

#### iii. Institutional Student-based Barriers

- Field courses are often not part of the curriculum for the major.
- The intensity of some curricula for biology majors can preclude a semester/quarter long experience at a FSML.
- There is a lack of minority role models/mentors at FSMLs, which can discourage some minority students.
- FSMLs are in many cases distant from population centers and main campus locations.

#### iv. Personal Student-based Barriers

- A large barrier for many students is the costs of attending specialized programs at FSMLs. These costs can be multiple and include the actual costs of attendance (e.g., housing, transportation, tuition), the loss of earning potential during attendance, and barriers such as the inability to break a housing lease on their main campus accommodation, thus entailing

double rent payments.

- Minority undergraduates may face strong social hurdles by attending FSMLs that are traditionally populated by non-minorities.
- Students may lack awareness of the availability and utility of field based courses both for personal and curricular goals.
- Many students have little knowledge about what types of careers are available to those pursuing field biology.

### 3. Recommended Strategies for FSMLs FOR UNDERGRADUATE EDUCATION

- As part of providing life long experiences in field biology FSMLs should continue to establish ways to involve students in field activities in their introductory college courses or experiences, e.g. incorporate field components in introductory level courses, offer mini-courses, initiate field biology clubs, and provide field biology career information. Distance learning should be explored as a potential to expose students early in their undergraduate careers to the value of field experiences. There is a need to explicitly define the unique contributions FSML courses can make in meeting the needs of the modern biology curriculum.
- A large percentage of students, often a relatively higher percentage of minorities, attend community colleges for their first one or two years of study. FSMLs are rarely associated with community colleges, and forging partnerships between FSMLs and community colleges could provide field experiences for these students. This could involve establishing FSMLs as regional “hubs” for field experiences for undergraduates from surrounding educational institutions.
- At the upper division level field experiences should continue to range from the incorporation of field work into main campus course offerings to the more intense experiences of a course and/or research experience at a FSML. The development of multidisciplinary programs that provide new, innovative models for undergraduate education should be encouraged. These could be national initiatives across sites, but there is also a role for small pilot programs that can be tested, evaluated, and considered for their potential wider dissemination.
- Field biology courses are diverse and should remain that way. There is a place for the traditional organismal group based course e.g. invertebrate zoology, which is best taught at FSMLs. There is also a need to continue to develop new integrative courses that incorporate theoretical principles, modern biological techniques, and multi- and cross-discipline structures. For example, courses which focus on experimental design and data analysis of ecological problems, and the linkage between systematics and cell and molecular biology. This can best be done through inquiry based learning in the “organisms’ natural environment”. The NSF Course, Curriculum and Laboratory Improvement program is well suited for the development of such courses and programs.
- Faculty professional development opportunities to plan field experiences based on modern educational practices need to be expanded.

- Successful research experiences for undergraduates expose them to the ways in which science is conducted and allows students to contribute to the process of research. It is a useful experience for both the undergraduate who plans to continue to a higher degree and for those that will enter the work force upon graduation with their bachelor's degree. One of the more successful programs for exposing undergraduates to biological research is the Research Experiences for Undergraduates Program. We suggest we build on and expand that program to provide additional opportunities for undergraduates (see recommendations to NSF below).
- There will always be the constraint of too few faculty and too many students for all students who want to have a research experience to be given that opportunity. The science community environment present at many FSMLs is conducive to helping undergraduates make connections with not only faculty but also scientists at other levels. For undergraduates from community colleges and non-M.S. or Ph.D. granting institutions a FSML experience is often the first opportunity they have had to interact with graduate students. We suggest capitalizing on the undergraduate/graduate interaction as a way of providing both groups with positive education opportunities. For example FSML faculty could establish a hierarchical mentoring program - faculty > grad students > undergraduates > high school students - that facilitates a research experience for a larger number of students. REU programs could take advantage of this hierarchical mentoring by encouraging mentorship of undergraduates by established graduate students.
- Undergraduates need exposure to research and other careers that are based in field biology. This can be greatly facilitated by capitalizing on the established very strong networks that FSMLs have with agencies and non-governmental organizations. An informal 1998 survey at the OBFS annual meeting of 42 FSMLs showed that 31% work with the US Forest Service, 14% with US Fish and Wildlife Service, 17% with the National Park Service. Given their potential to contribute to national monitoring efforts surprisingly few field stations work with the EPA (5%). At a state level 38% work with fish and game agencies, and 41% with state environmental protection agencies. 38% work with local governments. Nearly all field stations (71%) work with local environmental groups, or citizen organizations (60%). Many work with national conservation organizations, most particularly The Nature Conservancy (38%).

#### 4. Research and Evaluation NEEDS FOR UNDERGRADUATE EDUCATION

- Very few undergraduate programs at FSMLs appear to have undergone a rigorous evaluation. Thus for new initiatives evaluations should be planned from the very beginning, and we should look at ways to synthesize evaluation findings across projects. We should seek common themes through analysis of successful case studies; and use comparison groups to study differential effects of pilot projects.
- As previously discussed, there is a need for consistent cross site evaluation, collection of data, and

long term tracking of students if we are to obtain answers to questions such as the following:

- Do critical formative experiences lead to recruitment of undergraduates into biological sciences?
- What type of programs are the most successful for recruiting undergraduates, including minority students, to an interest in field biology and eventually a field biology career?
- What is the relationship between an undergraduate field experience and a decision to pursue a biology career?
- How important is an experience at a FSML in retaining a student in field biology after graduation?
- What types of experiences at FSMLs shape a students' career choice?

## 5. RECOMMENDATIONS TO NSF FOR UNDERGRADUATE EDUCATION

Undergraduates are exposed to field biology both in courses and by having the opportunity to conduct research. NSF supports both activities in a variety of programs. Here we suggest expansions of existing programs, and new ideas for increasing the involvement of undergraduates.

- NSF has consistently supported the understanding of research by undergraduates through the Research Experiences for Undergraduate program. We suggest an expansion of that program to include a diversity of program models:
  - i. Pre-REU programs that allow for increasing amount of background prior to getting into research environment. This could be especially important for students who rarely participate in traditional REU programs such as those from community colleges. This could be accomplished by using currently offered courses at FSMLs, or by developing new pedagogically appropriate courses where students are introduced to research by being guided in active inquiry field projects within a course framework.
  - ii. Additional year-round REU programs, rather than just summer, providing opportunities to coordinate with seasonal events. Such programs provide opportunity to build student's experiences over time.
  - iii. A new type of REU or IGERT type program that combines intense coursework characteristic of a FSML course with a cap stone type field research experience.
- NSF could explore ways to encourage community college and FSML faculty to forge links that would enhance the use of field sites in teaching. For example, supplements to existing grants could encourage community college faculty to jointly conduct research with FSML faculty and develop course materials appropriate for a field activity. The development of consortia of community colleges associated with a FSML should be explored.
- Hierarchical mentoring seems to be very effective at FSMLs where faculty and students have many opportunities for interaction. One way to enhance a mentoring role would be to offer mini-

grants for graduate students' research that would include having undergraduates work with them in the field.

### C. Community and Continuing Education Programs

Discussion of the environmental impact of human activities is in the daily news. In spite of this, many adults have a poor understanding of the complexity of the issues and how they can influence change through their own actions. Furthermore they have a poor perception of what science needs to be conducted to address a growing list of critical issues. Many local and national decision-makers also have the same poor perception of what science needs to be conducted.

FSMLs can be good sites for conducting educational programs for adult populations and decision-makers. FSMLs are normally more accessible and less intimidating than a major university campus, and often provide an opportunity for visitors to directly observe research in progress.

#### 1. CURRENT STATUS AT FSMLS

In 1995 65% (N=77) of FSMLs were engaged in some type of community and continuing education programs and it was reported that 340,000 people visited FSMLs for informal education programs for the general public (Lohr, et al. 1995). Programs range from tours to workshops and many involve partnerships with other education programs, e.g. nature centers, museums, master gardener programs.

#### 2. CHALLENGES FOR COMMUNITY AND CONTINUING EDUCATION PROGRAMS

Various strategies for programming in this area are possible, however not all are applicable to each FSML. Redundancy in programming with other educational entities should be avoided and programs should be developed at a FSML that best capitalizes on the strengths of the FSML institution and site. Many of the same institutional and faculty-based barriers exist for establishing these programs as were mentioned for K-12 programs. They include lack of educational leadership and unfamiliarity with this audience, a fear of compromise of research sites, and lack of faculty rewards for these types of activities.

#### 3. RECOMMENDED STRATEGIES FOR FSMLs FOR COMMUNITY AND CONTINUING EDUCATION PROGRAMS

- Interactions between FSMLS and other organizations are an effective way to reach larger target audiences. There are numerous examples where FSMLs are partnering with museums, nature centers, and state and federal government agencies to offer education programs to community and continuing education audiences. From these examples we see for these programs to function well it is important to develop strong communication between FSMLs and these organizations and to not duplicate educational programming activities.

- Partnering with organizations that target youth such as Girl and Boy Scouts, 4-H, Boys and Girls Clubs etc. has a potential for enhancing field experiences for these age groups. These organizations often require activities to fulfill requirements such as merit badge that could be conducted at FSMLs.
- Developing a group of volunteers can greatly assist in outreach activities by FSMLs. It does, however, require considerable time and continuing investment of resources to successfully set up and maintain a volunteer group. Volunteers can be involved in a variety of ways ranging from conducting tours to collecting data associated with long term monitoring at FSMLs. The added benefit of these volunteers is they often become ambassadors of the FSML program within the surrounding communities. In a like manner, involvement of volunteers as “citizen scientists, not only assists the program but increases the understanding of the conduct of science within the community. Retired university, K-12 teachers and industry scientists often are eager to become involved in long term measurements at a site, or within the surrounding community.
- The conduct of continuing education through professional development training for government agency employees through short courses on methods, e.g., GIS, have been successful at a number of FSMLs. “Eco Tourism” programs, Elderhostel or Earth Watch-like programs have high educational impacts but require significant commitments of time and resources.
- Inherent for the conduct of any of these forms of programming is sufficient staff to coordinate and conduct these programs and support from the administrative structure of the FSML to carry them out. Many of these programs do not require significant time of the faculty, however do require staff to continue to nurture volunteers, compile and synthesize data collected by “citizen scientists” and to manage residential programs, e.g., Elderhostel. Revenue streams created through professional development programs and Elderhostels can offset a portion of these costs, however often do not cover the total or “hidden” costs of this form of programming. Additional revenue streams through development activities have the potential for further offsetting costs since positive experiences of participants in programs of this nature can lead to their contributing to the continuance of these activities.

#### 4. RESEARCH AND EVALUATION NEEDS FOR COMMUNITY AND CONTINUING EDUCATION PROGRAMS

The value of any of these programs for increasing scientific literacy, better understanding of the environment, and of issues surrounding future management decisions need to be evaluated in order to determine which approach has the highest impact.

As discussed in other sections, there is a need for the development of a consistent evaluation instrument that would be used at all FSMLs. Information gathered should be centrally coordinated through OBFS and NAML. Cross-site synthesis would provide a mechanism for determining which type of programming has the greatest impact for specific target audience. FSMLs partnering with other

organization which have advanced evaluations in place, e.g., museums would provide training for FSML faculty and staff in evaluation and continuing education programs. Suggested areas for evaluation:

- How have these experiences changed the perception of science by these audiences? Have they become more supportive of science beyond concerns for health related issues?
- Have changing perceptions led to action on the part of the participants? Have they modified their life style or supported legislation to protect sensitive environments?
- Has participation in these programs led to an increased understanding and appreciation of FSML's research programs? Are they more supportive of FSML's activities through financial or moral support?
- How effective are volunteers as "citizen scientists" in data collection and in enhancing site data collections?

## 5. RECOMMENDATIONS TO NSF FOR COMMUNITY AND CONTINUING EDUCATION PROGRAMS

- It is recommended that the NSF consider planning workshop grants in the FSML competition that would facilitate partnerships between institutions to develop strategies for combined programming to facilitate community level programs.
- As previously discussed, the need for a consistent evaluation instrument to measure the impact of community based education program on participants and the FSMLs need to be developed.

## III. Increasing Diversity Within all Forms of Education Programming at FSMLs

### 1. CHALLENGES TO INCREASING DIVERSITY

Attracting non-traditional and minority populations to field experiences or to an interest in careers in biological sciences remains a significant challenge. Although minority populations continue to grow with respect to Caucasians, their representation in the biological sciences, especially field and organismal biology, remains exceedingly low. Many of these minority populations live in urban areas and currently have little or no exposure to or understanding of, a more natural environment. As voters, however these groups will be part of future decision-making on complex biological issues and the use and management of natural areas. Furthermore, increased representation of minority populations in the biological sciences would enrich and bring new perspectives to the field. Because of greater familiarity and perceived importance to society, other areas in the biological sciences such as medicine or biomedical sciences are more attractive for minority populations. Their low representation in non-biomedical sciences exacerbates the entire situation since without role models there is little encouragement or incentive for younger generations to pursue a career in these areas of science.

It is apparent that if we are going to be successful in increasing minority recruitment in the biological sciences, a significant commitment and changes in approaches need to be made. By their very nature, FSMLs are learning environments in which students and researchers interact in a more informal basis than in a traditional classroom setting. This often results in the development of a much stronger mentoring relationship than is possible in a larger University setting. These aspects of FSMLs are to foster connections that could increase minority participation in non-bio medical sciences. It must be recognized however that it requires considerable time to develop this understanding and to forge these connections.

Although media of many forms have increased exposure of underrepresented groups to more natural environments, increasing opportunities for experiences in the field remains a challenge.

#### i. FSML-based Barriers

- There are often few role models for minority or non-traditional students.
- Many FSML staff lack exposure and competence in cultures other than their own.
- In many cases FSMLs are located in areas with low populations of minorities and away from urban centers

#### ii. Student-based Barriers

- Lack of culturally familiar social support for minority students. In some instances Minority students need a critical mass in a setting dominated by majority students.
- Students' family or financial considerations may preclude students' ability to participate in programs.

## 2. RECOMMENDED STRATEGIES FOR FSMLs FOR INCREASING DIVERSITY

- Strategies to include underrepresented groups in field science experiences should include those suggested previously for K-12, undergraduate and community audiences. Attention needs to be focused however on how to specifically reach minority populations within these groups. A commitment to increase minority participation begins with recognition of cultural differences that can exist between minority populations and the culture of a FSML. Staff and faculty at FSMLs will sometimes need assistance and advice as to how to effectively incorporate minority populations into their programs. The most effective way for this transfer of knowledge is likely to be the development of connections, relationships, and partnerships with people and organizations that serve minority students. These partnerships will vary with location of the FSML and the type of program and many will likely require significant time and resources to be successful. Much of what is suggested below is aimed at attracting minority students to field experiences, but the ideas would also be appropriate for other sectors of society who have few opportunities for quality field based experience such as urban or low income rural populations, or older students returning to

school who must balance responsibilities to family and their education.

- Exposure to nature at an early age is particularly important for minorities as often they lack role models to pique the interest of students. Connections with teachers and administrators in minority dominated schools and the development of field experiences as part of science curricula is an important entry point in the K-12 system.
- Since minority participants in FSML programs often have the most exposure to sciences that can be linked to their everyday lives, e.g., medicine, it is important that FSML programs also relate directly to societal needs associated with participants' communities. In this manner the relevancy of FSML research will have a higher impact on these participants, and potentially lead to further interest in field biology.
- It is suggested that early repeated short-term experiences are more beneficial than immersion programs, which can be very intimidating to someone unfamiliar with the environment. One way in which FSMLs could facilitate this is to develop relationships with a teacher or program organizer who can serve as a positive supporter of the field experience. This person will have already built a relationship with the students and can facilitate the interactions between field station staff and the students. Making connections with community groups such as minority dominated church youth groups, tribal organizations, girl and boy scout troops, and building field based programs which would provide exposure to nature and research in field biology would provide initial and potential repeated exposure in the field.
- Some of the above approaches could also function at the high school level and additional programs that focus on minority students who show a strong interest in field biology could be implemented. For example, if students lived in close proximity to the FSML, independent after school research opportunities could be made available. Residential or non-residential research experiences or programs could also be provided in the summer, but residential programs would most likely have to be subsidized through external funding. Participants could be from the same schools that have participated in other programs so that they would have continued and increased exposure to field biology. The NSF Research Assistantship for Minority High School Students (RAMHSS) is a program that could help facilitate these experiences.
- At the undergraduate level it is important to pique the interest of both minority and majority populations of students in their first biological science courses. "The way we teach undergraduates can have the biggest effect on diversity. The quality of our teaching and scope of what we teach will lead to more diverse students getting interested in ecology" (Berkowitz in Baker, 2000). Implementations of reforms in undergraduate teaching in biology will potentially have an impact in this area at the college and university level.
- Traditional approaches of recruiting students or advertising courses or field experiences at FSMLs are not effective in increasing undergraduate minority participation. Rather we need to focus on developing the partnerships with individual faculty, community colleges, and four year

institutions that have highly diverse student populations. Such relationships have the potential to be long lasting.

- The Ecological Society of America's SEEDs program has promoted ecology at HBCUs by working directly with faculty at these institutions. The American Society for Limnology and Oceanography minorities mentoring program has markedly increased exposure of minorities to aquatic sciences ([www.aslo2.org/mas.html](http://www.aslo2.org/mas.html)). OBFS and NAML could work more closely with these and similar programs could be developed with other organizations in order to develop a pathway to a career in field biology. In some instances a FSML experience could be built into these pathways.
- Successful recruiting of minority students often requires a personal contact with institutions having high minority populations. FSMLs could take advantage of visiting minority faculty programs as a means of establishing these linkages. This would allow the minority faculty member to become acquainted with the FSML program and staff and potentially enhance the faculty's research. If the FSML experience were positive, this faculty member would be in a position to suggest and encourage students and other faculty from their parent organization to participate in a FSML program.
- Research experience opportunities at FSMLs through Research Experience for Undergraduates (NSF-REU) programs provide a common introduction to research in field biology. FSML based programs are however in competition with other REU programs on major campuses. If students have not had a previous exposure to field biology, they are difficult to attract to these programs since they will preferentially gravitate to more traditional campus based programs. Furthermore if faculty at their institution have had limited exposure to the field, they will not recommend these programs to their students. It is also difficult to attract a core group of minorities to provide the needed social support in an environment that is predominated by majority populations. Successful models associated with marine programs are at institutions with substantial minority populations or have partnered with institutions that do, e.g., HBCUs. Other programs solely are made up of minority populations (e.g. Western Washington's Shannon Point Marine Center Program). Because students from minority institutions often have insufficient backgrounds to approach a research experience, especially in field biology, "pre-REU" programs to provide enrichment for these students have proven successful (Savannah State and Harbor Branch Oceanographic Institution, A Bridge to Research in Marine Science Program). Partnerships with institutions that have or could have NSF Undergraduate Mentoring in Environmental Biology (UMEB) programs and supplements to existing NSF grants could provide additional opportunities for research-mentoring of minority students at FSMLs. An expansion of the UMEP program at NSF could facilitate these opportunities.
- Ways to further expose minority students to FSMLs should be explored. One idea is to invite minority student groups from local colleges and universities to use FSML facilities for meetings and retreats could also provide exposure to on site research. As part of these visits, a field experience or presentation which links FSML activities to current environmental/ecological

concerns, e.g. loss of biodiversity could be a valuable introduction to the importance of field biology and may spark interest within the group. This could be followed up with a discussion on opportunities, i.e., course work and research experiences at the FSML and at their parent institution.

### 3. Recommendation FoR NSF FOR INCREASING DIVERSITY IN FSML PROGRAMS

- NSF already has in place a number of initiatives to encourage minority participation in the biological sciences. An assessment of how these programs could be “modified” to increase the likelihood of a FSML experience would be beneficial.
- The NSF FSML planning grants could be expanded to allow FSMLs to plan for developing the partnerships that are so vital for success with minority involvement in FSML programs.
- Support for workshops or forums that link FSML faculty/staff with faculty at minority institutions and discuss mechanisms for increasing the exposure of undergraduates to field biology. Many FSML faculty and staff lack the knowledge or mechanism for interfacing with these institutions. Forums of this nature would provide an opportunity to explore and better understand the current barriers that prevent greater interactions between these two groups.

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### V. Appendix A Workshop Participants

**\*\* Members of the Steering Committee**

**\*\*Alan Berkowitz**

Institute of Ecosystem Studies, Box R, Millbrook, NY 12545  
845/677-5359 e-mail: BerkowitzA@ecostudies.org

**Kathy A. Coates**

Bermuda Biological Station for Research, Inc., Ferry Reach, St. George's, GE01  
BERMUDA  
441/297-1880 x 216 e-mail: kcoates@bbsr.edu

**Diane Ebert-May**

Department of Plant Biology, Michigan State University E. Lansing, MI 48823  
517/353-6486 e-mail: ebertmay@msu.edu

**Matt Gilligan**

Department of Biology, Savannah State University, Savannah, GA 31404  
912/356-2809 e-mail: gillganm@tigerpaw.ssu.peachnet.edu

**\*\*Jan Hodder**

Oregon Institute of Marine Biology, University of Oregon, P.O. Box 5389, Charleston, OR 97420  
541/888-2581, ex. 215 e-mail: jhodder@uoregon.edu

**Jerry D. Johnson**

Department of Biological Sciences, University of Texas at El Paso, 500 W. University Avenue, El Paso,  
Texas 79968  
915/747-6984 e-mail: jjohnson@utep.edu

**\*\*Michael J. Klug**

W.K. Kellogg Biological Station, Michigan State University, 3700 E. Gull Lake Drive, Hickory Corners,  
MI 49060  
616/671-2341 e-mail: Klug@kbs.msu.edu

**\*\*Marianne Krasny**

Department of Natural Resources, 16 Fernow Hall, Cornell University, Ithaca, NY 14850  
607/255-2827 e-mail: mek2@cornell.edu

**Ron Lawrenz**

Research and Collections Division, Science Museum of Minnesota, 120 W. Kellogg Blvd.  
St. Paul, MN 55102  
651/221-2539 e-mail: lawrenz@smm.org

Therese Markow  
Department of Ecology and Evolutionary Biology, Biosciences West 310, University of Arizona,  
Tucson, AZ 85721-0088  
520/621-3323 e-mail: tmarkow@arl.arizona.edu

Robert B. Matlock, Jr.  
La Selva Biological Station, Organization for Tropical Studies, Puerto Viejo de Sarapiquí  
COSTA RICA  
506/766-6565 e-mail: rmatlock@sloth.ots.ac.cr

Arthur McKee  
Andrews Experiment Forest, Oregon State University, P.O. Box 300 Blue River, OR 97413  
541/822-6300 – FAX: 541/822-6329 e-mail: mckee@fls.orst.edu

Eric Nagy  
University of Virginia, Mountain Lake Biological Station, 238 Gilmer Hall, P.O. Box 400327,  
Charlottesville, VA 22904-4327  
804/982-5486 and 540/626-7196 (summer) e-mail: enagy@virginia.edu

Sonia Ortega  
LTER Network Office, Department of Biology, University of New Mexico, Albuquerque NM 87131-  
1091  
(505) 272-7350 e-mail: sortega@lternet.edu

Jerome G. Rozen, Jr.  
American Museum of Natural History, Division of Invertebrate Zoology, Central Park West @ 79th  
Street, New York, NY 10024-5192  
217/769-5466 e-mail: rozen@amnh.org

\*\*Hilary Swain  
Archbold Biological Station, P.O. Box 2057, Lake Placid, FL 33862-2057  
863/465-2571 e-mail: Hswain@archbold-station.org

\*\*Steve Tonsor  
Department of Biological Sciences, University of Pittsburgh, Pittsburgh, PA 16424  
412/624-5491 e-mail: Tonsor@pitt.edu

Cindy Wilber  
Jasper Ridge Biological Preserve, Stanford University, Stanford, CA 94305-5020  
650/327-2277 e-mail: cwilber@leland.stanford.edu

Kathy Williams

Department of Biology, San Diego State University San Diego, CA 92182-4614  
619/594-4358 e-mail: [kwilliam@sunstroke.sdsu.edu](mailto:kwilliam@sunstroke.sdsu.edu)