

# **RUI: THE RESEARCH AMBASSADOR PROGRAM: EMPOWERING SCIENTISTS TO COMMUNICATE RESEARCH TO PUBLIC AUDIENCES**

## **I. INTRODUCTION**

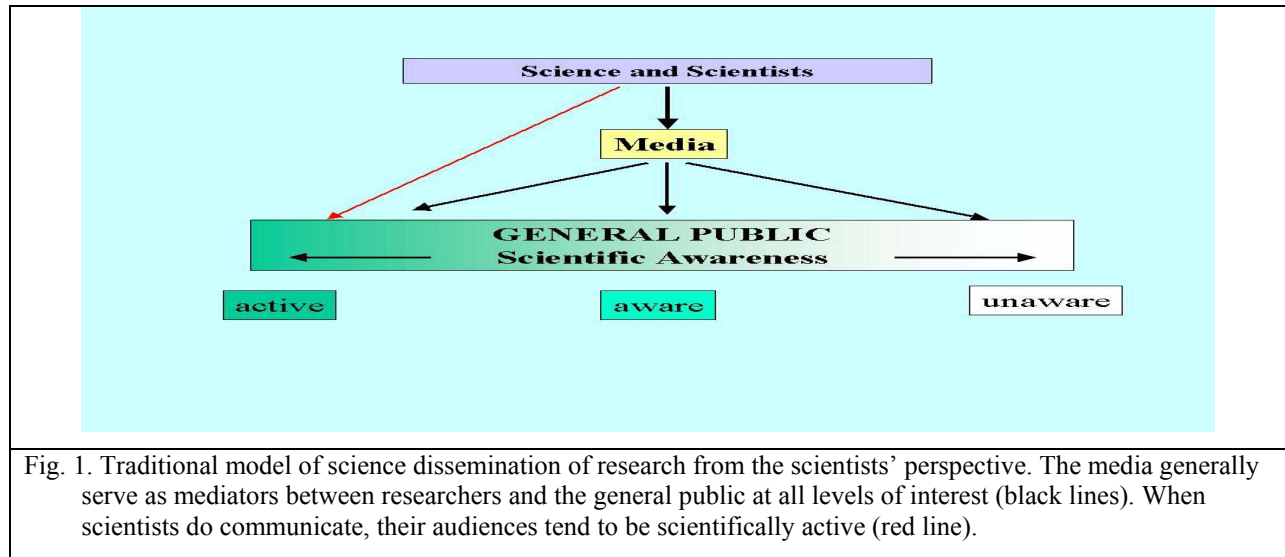
I wish to explore research and outreach activities that will, in the long term, potentially change the way that research scientists communicate the results of their work to society. This proposal is a first step in a long-term, large-scale effort I envision to help academic scientists communicate their passion for and knowledge of science to non-scientists in a way that will enhance their careers. In doing so, they will increase public awareness of the process and content of scientific discovery in our society.

I propose to initiate a pilot “Research Ambassador Program” in collaboration with scientists and informal science education (ISE) experts. My research team will assess the obstacles that scientists face in disseminating research to public audiences and train a cadre of Research Ambassadors (RAs) to overcome these barriers. Our pilot group will include six scientists who are directly or indirectly associated with my active NSF research projects: 1) the *Forest Canopy Database Project* (BD&I Program), and 2) the *Monteverde Forest Canopy Research Project* (Ecology Program). Building on this pilot program, I will later extend the program to other scientific disciplines and other ISE institutions.

### **I. A. STATEMENT OF NEED AND IDENTIFICATION OF RESEARCH PROBLEM**

Basic knowledge of science and an appreciation for how science is done is one of the key ingredients of a well-educated populace and a healthy society (Thomas & Durant 1987). A command of scientific content and an understanding of how to think critically play important roles in people’s lives (Gregory and Miller 1998). Equally critical is society’s recognition that learning about our planet’s biota is key to our survival. However, with the increasing dominance of technology, more frequent virtual rather than actual experiences, and media’s increasing representation of nature as entertainment, humans are losing their sense of connection to nature and science (Shamos 1995). An NSF survey of public attitudes toward science documented that Americans are highly supportive of science and technology, but 70% lack knowledge of the scientific process, and less than 15% described themselves as well-informed about science. (National Science Board, NSB 2002). Our society still adheres to stereotypes of scientists being antisocial individuals with little connection to mainstream society (Nelkin 1995).

Traditionally, the media have forged communication pathways between scientists and the public (Fig. 1) However, media communicators can only incompletely bridge the gap between scientists and non-scientists. Although many members of the media are articulate and dedicated, they are often hindered by fixed deadlines, lack of technical expertise in specialized subjects, and the perceived need to sensationalize research results (Friedman *et al.* 1986). This has resulted in a mistrust of the media (on the part of many scientists), and an impatience with seemingly defensive or inconclusive statements of scientists (on the part of the media) (Dunwoody 1992). Scientists often view the media as not sharing the same set of professional values as academics (e.g., accuracy, attention to detail, exhaustive treatment of a single specialized subject) and believe that many journalists are oriented toward oversimplification and inaccuracy (Goodell 1977).



When scientists do disseminate their research to the public, their audiences are almost always portions of the public who are already interested and knowledgeable about science – the scientifically “active/aware” (e.g., natural history groups, visitors to botanic gardens, readers of natural history magazines) (Fig. 1). Most scientists feel most comfortable with these scientifically literate audiences, as the listeners/readers already grasp the value of what might otherwise be considered esoteric research. Choosing to communicate with these societal segments makes the limited time scientists allow themselves for dissemination to be put to the apparently most efficient use. A negative consequence, however, is that the “scientifically unaware” segments of the population that most need direct input from scientists remain the least frequent targets of dissemination efforts of scientists.

To help reverse these trends, scientists themselves can become more directly involved in transmitting research to public audiences. Scientists can be powerful advocates for scientific studies for two reasons. First, they have specialized, technical knowledge of the subject matter. Second, their passion about what they study is infectious; it can inspire others to take an interest in science with surprising effectiveness. The need for scientists to have more direct interplay with non-scientific audiences, and to address audiences who would not typically gravitate to the normal forums for ISE has been recognized by informal science educators (Gregory & Miller 1998). However, from the standpoint of the scientist, communication of science to the general public -- either individually or via the mass media -- is only minimally valued within the reward system recognized by scholars. Despite some high-level approval of the scientific community, efforts at popular communication are viewed at best as a distraction from the “real work” of academics (e.g., writing grant proposals, producing scholarly articles for scientific audiences). At worst, these efforts have been met with disinterest or jealousy (Bodmer 1986).

In longer- term and larger-scale perspectives, however, such efforts can result in positive feedback for scientists via an improved social and political climate that is supportive of research activities and funding. In an article in *Science* [1999; **283**:1461-1463], the writer/physician Michael Crichton articulated the pressing importance of scientists to become translators and ambassadors of science to the general public:

“You need working scientists with major reputations and major accomplishments to act as human examples, demonstrating by their presence what a scientist is, how a scientist thinks and acts, and explaining what science is about... You can never convey a sense of real science only through movies or TV shows. You can only do that by exposing real scientists to the waiting public...”

Although many scientists are capable of conveying and willing to communicate the excitement and importance of their work, they need help to overcome existing obstacles to get their messages beyond

academic audiences. In the proposed project, I will explore the process by which scientists can become more effective communicators to the general public – with a focus on scientifically unaware audiences – in ways that will enhance rather than inhibit their scientific careers.

## **I. B. TARGET AUDIENCES**

The activities I propose can reach all segments of the general public, categorized as follows: 1) the *scientifically active* – those who express a high level of interest in a particular issue, and feel well-informed about it (termed the “attentive public” in NSB 2002); 2) the *scientifically aware* public, who claim to have a high level of interest in an issue, but do not feel well-informed about it (=“interested public”); and 3) the *scientifically unaware* – those who are neither interested nor feel well-informed about an issue (=“residual public”).

The major thrust of the activities I propose is to awaken awareness about the importance of research to segments of the third category, the *scientifically unaware* public. i.e., those who might not ordinarily watch a PBS television special, subscribe to a natural history magazine, or visit a science museum. Within that cohort, I will focus on two target groups. The first will be adults who have some compelling interest, hobby, or avocation that can be directly or indirectly linked to our understanding of trees and forests. This group may not gain access to science in traditional ISE venues. However, once made aware of links to their own interests, they may become sufficiently interested to “jump” to the next levels – to being scientifically aware or scientifically active.

The second group will be youth from urban areas (for this pilot project, from inner city areas of the Puget Sound area). We will focus on at-risk youth, determined by indicators of students who come from communities with limited resources and are thus most likely behind in understanding of scientific issues. These indicators are percentages of students needing free and reduced school lunches, and the WASL test scores. The rationale for choosing youth from this group is that they fall significantly behind in their awareness and understanding of scientific issues and methods, relative to other youth groups (NSB 2002). They are also in greatest need of reinforcement of awareness of the connection between humans and nature, because natural systems are largely not visible in their immediate surroundings (Jolly 2002).

## **II. BACKGROUND INFORMATION**

### *II. A. NSF Research Background (see also Results of Prior Research)*

My research broadly concerns the ecological interactions of the forest canopy. I have received continual NSF support since 1987 to study the ecology of canopy-dwelling organisms and their roles in ecosystems. My current Ecology Program grant focuses on the effects of human and natural disturbances on canopy communities. In the montane landscape of Monteverde, Costa Rica, my research team and I quantify seed rain, flowering times, and litterfall within the canopy and on the forest floor. We also use an experimental approach to quantify the effects of predicted global climate change using epiphyte transplants.

My colleagues and I have also developed the canopy research field itself by developing database tools. Our team of ecologists and computer scientists were awarded three consecutive grants from BD&I to establish methods to collect, display, analyze, archive, and interpret 3-D spatial data relating to tree crowns and forest canopies and create the “Big Canopy Database”. To enhance communication among canopy researchers and those in allied fields, I created the International Canopy Network (ICAN), a self-sustaining non-profit organization, with an e-mail bulletin board, quarterly newsletter, directory, and citations database on canopy studies. I have transmitted my research results to scientists through numerous papers in scientific journals, books, symposia, and invited talks at scientific meetings.

### *II. B. Traditional Public Outreach and Dissemination*

I have also disseminated my research to the public, mainly to scientifically aware and scientifically active audiences. These media include popular articles for adults (e.g., *National Geographic*, *Audubon*, *Glamour Magazine*) and youth (e.g., *Ranger Rick*, *National Geographic World*, *Boy’s Life*, *Scholastic*); talks for

youth, civic, and natural history groups (e.g., Girl Scouts, Rotary Club, Washington Native Plant Society); and endowed lectures for the public (e.g., Jane and Whitney Harris Lectureship, Margery Stoneman Douglas Endowed Lecture, Morgan Endowed Lecture in Science). I have also appeared on television programs and films (e.g., National Geographic Society's *Heroes of the High Frontier*, *Good Morning, America*, *Bill Nye the Science Guy*, *The Voyage of the Mimi*, IMAX film *Tropical Rainforests*). Several of the latter were sponsored by NSF's ISE program.

### II. C. Non-traditional Outreach Efforts

Concurrent with these research and dissemination activities, I explored new ways to document the values of trees and canopy biota and disseminate them via non-traditional pathways, supported by a Guggenheim Fellowship (2001-2002) and grants from the National Geographic Society's (NGS) Conservation Trust (2000-2003). The concept behind these efforts was that "scientifically unaware" individuals might be open to an alternate strategy. My idea was to link activities that excite or intrigue the non-scientists to forest canopy research that directly or indirectly relates to those activities or interests.

#### II. C. 1. Religious venues:

One such realm is religion. A religious person may not be inclined to visit a science museum on Sunday morning, but rather to spend it at his church. Therefore, if a scientist can link what she studies to something that is valued by that religion, then the church itself could provide a venue for dissemination of research by the scientist, which would raise the churchgoer's awareness about science.

In 2001, I started outreach work in places of worship. I visited 12 churches of many faiths, focusing on Christianity. I downloaded the Old Testament from the web, did a search for all references to the term "tree" and "forest", and categorized the 328 references into seven groups (Ancillary Materials (Anc. Mat.) 1; see hard copies and website: [www.evergreen.edu/ican](http://www.evergreen.edu/ican) with "NSF REVIEWERS" button).

References to trees and forests encompass an enormous breadth of Biblical values and activities. I was invited to give sermons on "trees and spirituality" to over a dozen Protestant and Catholic churches, interfaith congregations, Jewish synagogues, and Buddhist temples. I also wrote articles for church newsletters. At each talk, I made available information sheets to inform listeners about scientific sources of information about forest canopies (websites, publications, popular articles).

#### II. C. 2. Sports and Toys

I connected trees with recreation by linking sports items with their source. For example, in the major leagues, baseball bats must be made of wood. I designed and am marketing baseball cards that have images of major baseball players stating the importance of trees (Anc. Mat. 2). The reverse sides list the ICAN website, which provides information on trees and links to scientific and popular article databases. Similarly, skateboard decks are made of wood, so I designed skateboards with a canopy logo, which we distribute at regional skateboard parks where the users are almost entirely urban youth (Anc. Mat. 3). I created a "TreeTop Barbie Doll", which I am marketing to Mattel, Inc. and Get Real Girls, Inc. (Anc. Mat. 3) to present an alternative to traditional dolls – one that embodies exploration, strength, and an image of a young woman interested in forest science. Links to the ICAN website accompany the package.

#### II. C. 3. Health and Hospitals

After one of my church talks, a medical doctor in the congregation invited me to speak about trees and healing to medical residents at his regional teaching hospital. I presented examples of how health practitioners can use trees and images of trees to provide hope and inspiration for their patients. For example, cancer patients who face regimes of chemotherapy might be encouraged to learn that trees can sustain tumors ("burls") for centuries. Amputee victims might gain heart by knowing that trees lose limbs and adapt to the loss by growing epicormic branches. The death of individual trees creates light gaps for young saplings in the rainforests. In the evaluation of this talk in the residents' seminar series, over 65% of the residents stated that they felt that the talk was "useful or "very useful" to their ability to treat

patients (Anc. Mat. 4).

#### II. C. 4. Links with Art and Music

In summer 2002, I implemented a project to bring people who focus on aesthetic values to the canopy. We installed four forest canopy platforms in an old-growth and secondary forest in Washington State. Nineteen visual artists and musicians spent a week at the site, with 3-hr shifts in the canopy. The results have been stunning: pastels, acrylics, charcoal images; and oboe, bamboo flute, opera, and classical guitar music that capture the aesthetic values of the forest canopy (Anc. Mat. 5). The artists in the initial group rapidly recruited a cadre of artists for a second session through their professional contacts and networks.

#### II. C. 5. Links with urban youth

Promoting awareness of nature can be challenging for at-risk and urban youth, groups that manifest the greatest gaps in performance in science and math achievement tests (NSB 2002). I invited an Evergreen freshman, George “Duke” Brady, raised in central San Francisco, to our campus canopy platform. He composed a rap song about the canopy (Anc. Mat. 6), which linked his passion for rap music with forest canopies. A Research Experience for Undergraduate Grant Supplement on my Ecology grant allowed Duke to present his rap music in person to tropical biologists at the annual meeting of the Association for Tropical Biology (ATB) in Panama City (Aug., 2002). Duke performed his song during my plenary keynote talk to a group of 600 tropical biologists. It met with astounding enthusiasm. Duke’s efforts also inspired a group of graffiti artists at Evergreen to paint a large (4’x 24’) mural that depicts the forest canopy. The artists included both wildland and urban elements. (Anc. Mat. 6). This demonstrated that inspiration can “leap-frog” from one non-scientific audience to another, which can greatly broaden the impacts of an individual scientist’s dissemination efforts.

#### II. C. 8. Legislators Aloft program

To explore how decision-makers and scientists communicate about policy issues, I invited 12 state legislators and their aides to the canopy. In September, 2002, we installed platforms in a local park and taught the congresspeople to ascend. In the several hours we spent aloft, discussions included forest management issues, government funding of science, the reasons for high biodiversity in the canopy, and the importance of non-vascular plants in forest nutrient cycles. Our post-session evaluation (a written questionnaire distributed at the session with an email follow-up) documented that over 90% of the audience felt “positive” or “highly positive” about the experience, and 75% stated that they would be willing to contact a forest ecologist in the future.

#### II. C. 7. Followup with research information

The activities described above constitute the first step in communicating research information, i.e., awakening the awareness of the audience (Fig. 2, left side). However, it is critical to provide content and pathways for action as a followup (Fig. 2, right side). I used a web-based approach to provide followup information in conjunction with the ICAN (see Institutional Partners). We created a website ([www.evergreen.edu/ican](http://www.evergreen.edu/ican)), which presents information on forest canopies for researchers, educators, and conservationists, and includes materials that are both academic (e.g., citations database, images database) and non-academic (e.g., popular articles database, information on canopy access and safety). We also presented short video tapes of talks that describe topics concerning forest canopy research on the ICAN website using FLASH software and slides. I am writing popular articles for newsletters and speciality consumer magazines that correspond to the topics described above (e.g., *Dharma News* and *Christianity Today* for the trees and spirituality lecture, *Junior Baseball* for the baseball bat/tree connection, and *Dolls Magazine* for the TreeTop Barbie).

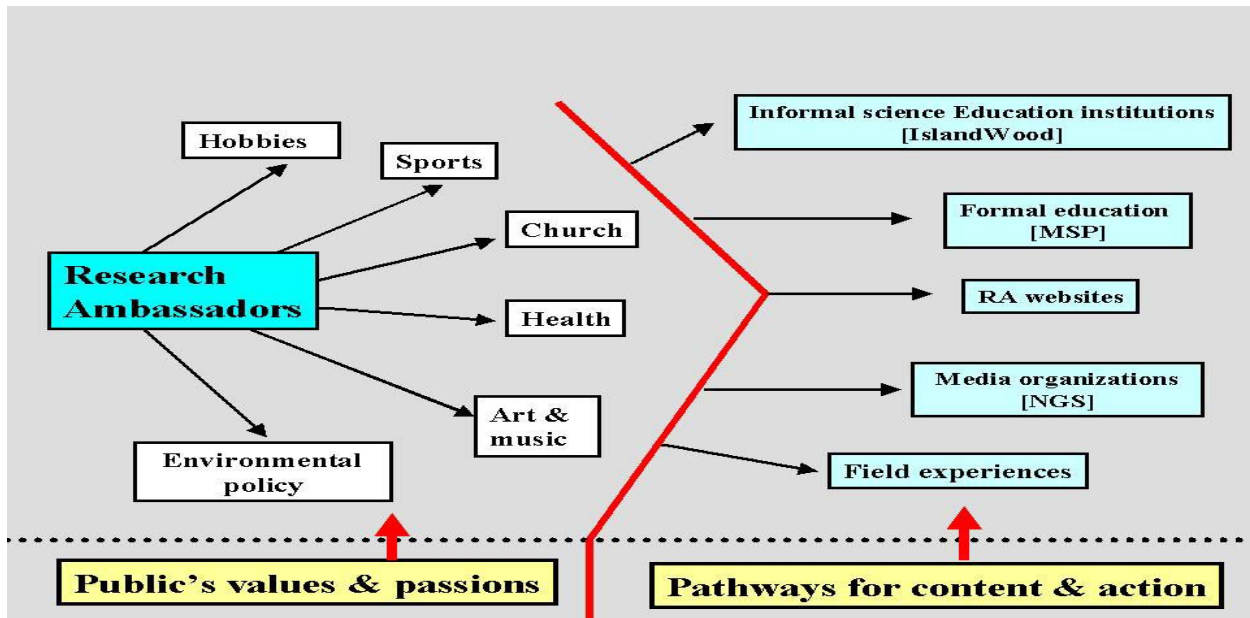


Fig. 2. Schema for raising awareness of general public. Research Ambassadors will relate their topics to aspects of the public's values and passions (left side). Additional content and further dissemination will occur through institutions and guided experiences, represented by organizations on the right side.

#### II. C. 6. Reactions from Academics

How do academic scientists react to these activities? In 2002, I gave invited seminars at research universities (e.g., Stanford University, Univ. of Washington), and keynote plenary talks at large meetings (e.g., Association for Tropical Biology annual meeting, Panama; 3<sup>rd</sup> International Canopy Conference, Cairns; German Tropical Biology Organization, Göttingen), in which I described results of my public outreach activities. Contrary to my expectations and fears that fellow academics would find these efforts a waste of time, my academic colleagues corroborated the idea that outreach is important to them, but they seldom overcome the outreach obstacles described above. Over three dozen unsolicited researchers at the junior and senior level have contacted me to learn how to replicate activities for their own research.

#### II. C. 7. Lessons Learned from Background Work

I learned the following lessons about scientist-mediated dissemination from these experiences:

- Non-scientists are open to contact with researchers when they are in non-scientific settings (e.g., ministers and rabbis welcomed me to the pulpit even though I am not of their faith);
- Non-scientists have well-developed networks based on their own interests and values, and can link a scientist into those networks (e.g., artists involved with the NGS project introduced me to other artists);
- Networks link to other networks; i.e., an individual in one non-scientist audience would refer me to other non-scientist audiences (e.g., member of a congregation invited me to speak at a hospital);
- Individuals from one non-scientist group directly influenced individuals in other groups in a “leap-frog” action (e.g., rap singer influenced graffiti artists to create canopy artwork);
- Non-scientists are often amazed that scientists want to and are capable of communicating with them (e.g., legislators were surprised at the effort we expended to get them into the canopy and that we were informed on legislative issues of common interest);
- Non-scientists frequently generated observations and questions that were novel and useful to me, because of their fresh perspective and new eyes (e.g., a question about whether nutrient content in

- needles varies with height elicited research on my part);
- Non-scientists are as passionate about their own interests as scientists are about scientific interests, and if you can link the two, then there is a powerful potential for education in both directions.

### III. PROJECT APPROACH

The ISE arena into which the proposed work fits is in the broadest interpretation of “free-choice learning”, (the type of learning that occurs outside of school, sensu Falk 2001). Recent research strongly suggests that the more the separate influential spheres of family, school, work, and elective learning overlap in people’s lives, the more likely they are to become successful lifelong learners (Brice Heath & Smyth 1999, Epstein 1995). Traditionally, free-choice learning has referred to the type of learning typically facilitated by museums, science centres, a wide range of community-based organizations, and print and the Internet. It is characterized by being nonsequential, self-paced, and voluntary, and recognizes that the interchange goes on between the individual and his/her sociocultural environment (Falk 2001).

My vision is to train scientists to communicate to non-scientists, especially to the ‘scientifically unaware’, in carefully-chosen arenas of free-choice learning that are based on the interests of the audiences themselves. My research team and I will help guide the RAs to relate what they are studying to aspects of life that segments of the scientifically unaware are passionate about, and in doing so, motivating them to become more aware about science. My approach is partially patterned after the U. S. Department of State’s Foreign Service. That agency successfully recruits and intensively trains its cadre of ambassadors, attachés, and liasons from diverse backgrounds to communicate information about their home country to citizens in other countries, and to gather information about them for their own countries.

The central idea is that a scientifically unaware person is best reached by identifying the activities or realms of society that excite or intrigue him or her, and then linking the science research to those activities or realms. For the proposed Research Ambassador program, this will involve our team understanding the research of the RA; developing a strategy to link the content to something that the scientifically unaware public values; developing talks, articles, or other media to enter into the other “country”; and providing materials that will give greater depth after the public communication. This will lead to a jump from unaware to aware, and from aware to active via the public gaining more insights through access to websites or other research resources. This in turn can lead to a greater appreciation and actions that the public can take, which will provide a positive feedback loop for the process (Fig. 3).

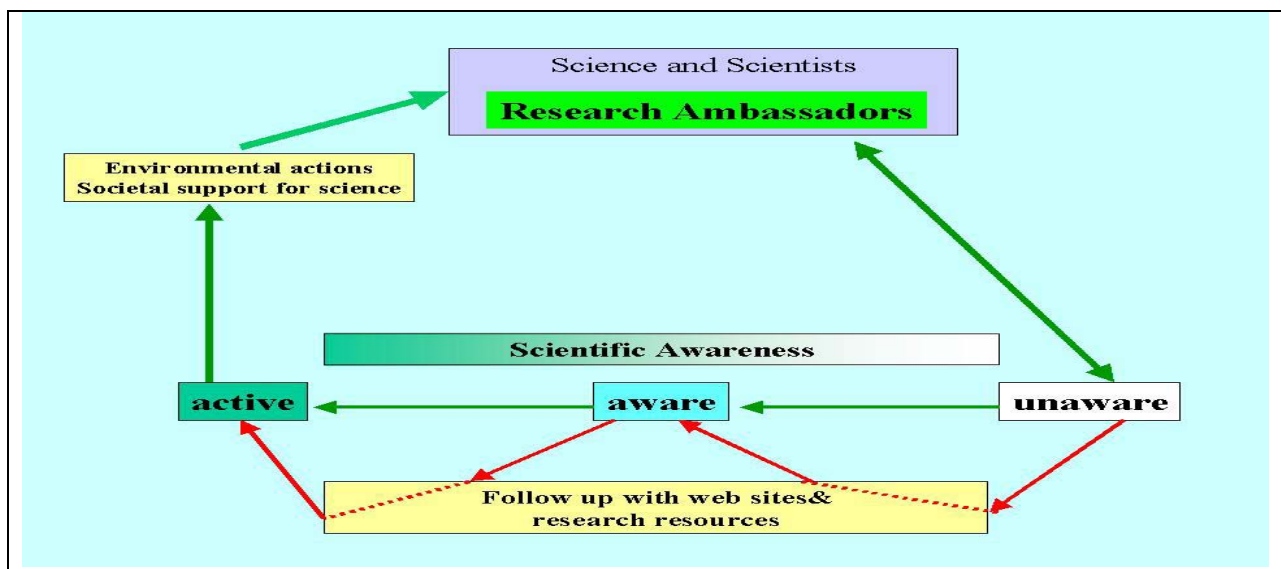


Fig. 3. Research Ambassador model of dissemination by scientists. RAs disseminate information to the unaware,

which is followed up by subsequent exposure to websites and research resources. This promotes stepwise increments of growing awareness that may lead to environmental actions and societal support for science and scientists.

## IV. PROJECT DESCRIPTION

### IV. A. Project Objectives

The four objectives of this pilot project are to: 1) explore the obstacles that scientists face when trying to disseminate research results to non-scientists, particularly to scientifically unaware audiences; 2) provide concrete assistance to a cadre of forest scientists to overcome those barriers; 3) provide newly aware audiences with sufficiently engaging and accessible content to move them to a higher level of awareness and activity; and 4) evaluate the protocols and modify them to extend the work to other scientists and other fields of science in the future.

### IV. B. General Approach

I wish to pursue projects that will, in the long term, potentially change the way that research scientists communicate the results of their work to society. I will extend my past outreach activities to the Research Ambassador Program. A network of collaborating institutions and I will provide the resources to facilitate direct communication between scientists and segments of the general public who have traditionally been overlooked or under-exposed to scientists and scientific research results.

We will encourage our RAs to be creative and courageous in the choice of their audiences. For example, a post-doc who has been studying the *biological diversity* of canopy invertebrates in our tropical forest study sites might talk to a meeting of university administrators, who are trying to understand ways of maintaining *human diversity* in the work place. Another researcher, who studies nitrogen budgets – the pools and flows of nutrients in the ecosystem - might speak to a group of bankers, who are concerned with pools and flows of money in their monetary budgets. I anticipate they will find shared interests in some aspects of their work (e.g., issues relating to benefits of diversity, types of spreadsheets used to keep track of budgets, respectively). The two-way information flow between the seemingly disparate groups will be stimulating and reveal common ground between scientists and non-scientists.

This outreach work will help disseminate the results of my own NSF research projects. I will identify researchers who have been directly and indirectly involved with my research and enlist them as potential RAs. I will also work towards extending this to others outside past collaborative activities and in other research fields.

### IV. C. Project Structure

I have identified five specific obstacles that most academic scientists face when confronted with the prospect of communicating to the scientifically unaware:

- Lack of academic recognition
- Lack of financial rewards
- Lack of time to find and engage contacts and partnerships in non-scientific worlds
- Lack of materials for and ignorance of the appropriate level of communication
- Inability to efficiently evaluate effectiveness of dissemination activities

To overcome the obstacles that traditionally block scientists from direct contact, each Research Ambassador will be given the following five items:

- academic recognition via an approving letter from a highly visible and well-respected figure (e.g., Dr. Bruce Alberts, President of the National Academy of Science), which can be included in a scientists’

- academic file for review/promotion/tenure decisions;
- an honorarium as financial reward to represent societal value;
- a set of contacts to reduce “overhead time” for researchers: a) contacts for local liasons and institutions (e.g., civic clubs, churches); b) a list of media and publications contacts and their guidelines, as outlets for popular articles; and c) contacts for formal education connections, such as school teachers and teacher training.
- a set of images, model videotapes and articles that will serve as background/context for talks or articles to help the RA establish the appropriate communication level;
- Evaluation instruments and feedback to assess the RA’s dissemination efforts.

Each RA will commit him/herself to perform the following six activities, which will take 18-20 hr of professional time:

- Respond to an interview to determine current obstacles to dissemination to the public [2 hr];
- Provide time for a video interview and “lab tour” to be filmed by our team for use as a webstream and video [4 hr];
- Give at least one talk to non-scientists - civic, religious, youth, or social groups that may be recorded and disseminated on an appropriate website [2 hr];
- Write, co-author with us, or review one article for the popular press/magazines [4 hr];
- Attempt to recruit at least one colleague to the RA program [2 hr];
- Evaluate experiences via an “exit interview” by our group [4 hr]

#### *IV. D. Research Plan*

To seek, train, and evaluate RAs, my research team and I will carry out seven steps:

##### IV. D. 1. Recruit Research Ambassadors

At the outset of the project, I will construct a website to inform the general community about our progress and to recruit new RAs. I will recruit six scientists who can disseminate the research results. Five of these are scientists with whom I have actively collaborated in research from my two active NSF awards (see Results of Prior Supp.). Although I have other active colleagues who could fill the remaining slots, I will recruit and engage at least one other with whom I have not previously collaborated, to test whether the system can work outside of previous contacts. I will carry this out by: 1) giving talks about these activities at professional meetings; 2) sending messages on academic email bulletin boards (Ecological Soc. Of America and ICAN; and 3) writing articles for research newsletters (e.g., Ecol.Bull., ICAN newsletter).

##### IV. D. 2. Conduct entry interview

In conjunction with the Evaluation Consultant, we will gather information about the obstacles, research, and desired outcomes of each RA. This will take the form of a telephone or video conversation (for RAs not at the home institution) or in person (for RAs at the home institution). We will help the RA define his/her research questions, potential links to non-scientist focal group(s), and a time frame for related activities. We will also inform the RA of all of the rewards and responsibilities of the RA program.

##### IV. D. 3. Document research activities and establishment of RA links

Our team will visit the lab and/or field site of each RA to document the questions and results of the research projects; record the researcher carrying out and discussing his/her research on video; and discuss in detail the possible local links for talks and collaborations. We will develop a SPOT team (Science Promotion and Outreach Team) that will consist of two undergraduate students (one each from the Media and Environmental Studies Depts. at Evergreen); the ISE consultant, the PI, and the Project Coordinator.

We anticipate spending one full day at the lab/field station, interviewing and filming the RA and filming footage from his/her students, staff, and the surrounding area. We will also gather relevant scientific articles, view existing websites and databases, and other research resources such as collections and images. Team members will also train student(s) or staff in the RA lab to take videos. We will then brainstorm potential links to the different public audiences and focal points we will target. We will spend up to one more day to investigate potential local or regional sites for a public talk, and to pinpoint the actual contact people. For example, one potential RA, J. Longino, studies biodiversity of insects. We could link him up with regional insect pest exterminator companies. The work of D. Briggs, who studies wood anatomy is of interest to hobbyist wood carvers and sculptors, so we would provide contacts with the South Puget Sound Wood Carver's Club (Table 1).

#### IV. D. 4. Guide RA in Delivering Public Talks and Writing Popular Articles

Our team will help each scientist create engaging, well-illustrated talks for the public. We will provide examples of talks (on video) for the appropriate level. If a scientist requires images, our team will procure these. We will review the talks before they are delivered for the first time. These talks will be filmed by a member of the RA lab for potential distribution via the RA's website.

To assist the process of writing popular articles, we will identify one or more potential publications through "*Writer's Market 2003*" and other popular writing sources. Depending on the skills and available time of the RA, we will either co-write, edit, or review one or more popular articles on the topic for a trade, consumer, or hobbyist magazine. For example, R. Rader, an RA who studies arboreal rodents, could write an article on the behavior of arboreal mice in the wild that would be of interest to the readers of *Pet Age*, the hobbyist magazine for fancy mice and rat breeders.

One of our target audiences is urban youth. We will make contact with this audience through the newly established IslandWood, on Bainbridge Island, Washington State (see Collaborating Institutions). Their programs integrate scientific inquiry, technology, and the arts, helping children develop a deeper understanding of the relationships between biological and cultural diversity. Operating from sustainably designed facilities, they draw mainly urban children to stay for 4-day sessions on their 255-acre forested campus. We will interact by having 2-4 RAs act as "Scientists-in-Residence" and disseminate research directly to resident students, teachers, and the local community in the form of lectures or workshops; interact with staff to develop lectures and workshops, and review scientific materials produced by staff.

#### IV. D. 6. Develop Follow-up Distance Learning Materials

Americans' use of the Internet in the last few years has grown substantially in all sectors, with 54% of the nation online. Children and teenagers use the Internet more than any other age group, with 90% of children using it (US Dept. Commerce 2001). The web is thus an appropriate place to present follow-up materials for those exposed to the awareness-awakening talks and papers of the RAs. For each RA, our team will set up a website either on the RA's server, or on a central RA Program website that we establish at the beginning of the project. If the scientist already has a website (probably oriented towards other scientists), we will augment it so that it also presents a public-friendly interface. The website, designed in conjunction with our website consultant, will be graphically pleasing to non-scientists and easy to negotiate to allow for easy viewing by an audience that may not have experience with academic websites. The interviews and talks given by each RA will be made available through online webstreaming.

We will follow the model of an existing outreach website, VRV-ET, which was developed at Univ. of Oregon with NSF support (ITR). The computational infrastructure – "Virtual Research Vessel" (VRV), supports interdisciplinary data sharing and facilitates the use of data, maps, and models related to the East Pacific Rise. They also developed tools to disseminate to the K-12 and undergraduate curricula. Their electronic toolkit, VRV Education Technology (VRV-ET) is available to help scientists build web sites that allow users to take "virtual" field trips. I have done preliminary work with this program to document field trips for a class I taught at Evergreen <<http://hydros.csi.uoregon.edu:8080/moss/>>.

#### IV. D. 7. Conduct Exit Interview for Assessment

After the completion of RA activities, we will carry out an exit interview to ascertain the RA's perception of the values of the program for his/her own work. We will design an interview with the guidance of our Evaluation Consultant. This will be critical for ameliorating the design for future RA activities.

#### **V. PROPOSED INSTITUTIONAL PARTNERS, CONSULTANTS, AND COLLABORATORS**

I will draw upon new and existing collaborative relationships with four organizations. Each of these represents one type of dissemination network (Fig. 2). Detailed information is in the Facilities Statement

1. **MEDIA NETWORK REPRESENTATIVE: National Geographic Society** (NGS) supports media, education, and research activities on a broad spectrum of topics including geography, ecology, and the natural sciences.
2. **SCIENTIFIC NETWORK REPRESENTATIVE: A) The International Canopy Network** (ICAN) is a non-profit organization whose mission is to facilitate communication among researchers, educators, and conservationists concerned with forest canopies.
3. **EVALUATION EXPERTISE: The Center for Children and Technology** (CCT) serves as the external evaluator for a wide array of educational technology programs, undertakes formative evaluations of pilot projects, develops embedded evaluation procedures for ongoing internal project assessments, and tests evaluation methodologies and instruments, all using quantitative and qualitative methods designed specifically for each project's needs and goals.
4. **INQUIRY-BASED YOUTH EDUCATIONAL REPRESENTATIVE: IslandWood's** primary focus is experiential-based learning and outdoor field experiences for children from urban areas of Seattle and King and Kitsap Counties.

*Project Director, Nalini Nadkarni:* As Principal Investigator of the grant and Project Director, I will direct and take responsibility for all aspects of the project. I will supervise the Project Coordinator and coordinate the consultants and collaborators. I will be responsible for writing progress and final reports.

*Project Coordinator (David Franklin):* D. Franklin has served as Coordinator for the ICAN since 1999. He brings experience in database management, graphics, newsletter production, and large project coordination as well as familiarity with the research and outreach projects of the Evergreen Canopy Lab. He will join the Masters in Teaching program as a part-time student. Franklin will arrange for travel and logistics; solicit contacts in RAs' home areas, and provide continuity for media productions.

*Informal Science Education Consultant Laurie Weisman,* currently an Executive Editor at *Time For Kids*, a division of Time, Inc., has been working in the arenas of informal and formal education for 22 years. As Vice-President, School Products at Sesame Workshop, she designed and produced educational media for children, families, and teachers from broadcast television to books, classroom videotapes and CD-ROMs. She played key roles in developing groundbreaking, television-based multiple-media projects including Sesame Workshop's *Ghostwriter* and *MATHmatazz*, and Bank Street College's *The Voyages of the Mimi*. She brings creativity, management skills, multiple media production experience, and experience communicating complex ideas to a variety of audiences.

*Evaluation Consultant (M. Honey, CCT):* The Evaluation Consultant is a professional who has experience in formative and summative evaluation, developing and analyzing effective questionnaires and interviews, and sufficient background in natural history/ecology to be conversant with the scientists. She is an expert in fostering creative and lateral thinking processes.

*Website consultant (Matt Dreisbach):* Mr. Dreisbach is a graduate in computer science (2000), and has worked with me on a website projects that involve the dissemination of a forest ecological field projects using the VRV-ET program described above.

*Collaborating Research Ambassadors:*

I have identified five Research Ambassadors who have expressed interest in this program, and will recruit one other scientist during the course of the project. These encompass a wide range of scientists with respect to geographical location, areas of research, and relationship with my home institution. Below I identify their background and potential links to non-scientist groups.

Name	Institution	Field of interest	History with NSF/NN's projects	Potential subject and magazine outlets for links to non-scientist audiences
Roman Dial	Alaska Pacific Univ.	Forest structure & airspace	Collaborator on NN's BD&I grant, ROA award	Architects: Amer. Institute of Architects (AIA) National Convention and Design Expo, May, 2004; <i>Architectural Record</i> trade magazine.
Jane Carter Ingram	Oxford Univ., U.K.	Tropical forest nutrient cycling & remote sensing	Collaborator on NN's Ecology grant	Bankers: Amer. Bankers Assn. annual meetings; Independent Community Bankers of America <i>America's Community Banker</i> trade magazine.
John Longino	Evergreen State College	Invertebrate biodiversity & taxonomy	Biotic Surveys & Inventories ('92-'05)	Exterminators/pest control: National Pest Control Assn (NPCA) region meetings; <i>Bee Culture</i> trade magazine.
David Briggs	Univ. of Washington	Wood anatomy	None	Washington Wood Carvers Association (WWCA) quarterly meetings (statewide); <i>Popular Woodworking</i> magazine.
Romina Rader	James Cook Univ., Australia	Canopy rodent ecology	None	Pet stores & hobby mouse breeders: Amer. Fancy Rat and Mouse Assn. (AFRMA) regional competitions 6x/hr; <i>Pet Age</i> , pet industry's trade magazine.
Unknown (1)	To be recruited			

## VI. LINKS WITH FORMAL AND INFORMAL EDUCATION

### VI. A. Informal Science Education

I have selected IslandWood (IW) as a regional and representative institution that can serve as a model for other ISE facilities. Currently, IW conducts an Artist-in-Residence (AIR) program as part of the School Overnight Program, which serves 3500 children per school year. Professional artists offer their knowledge and experience as they teach and create alongside children and adults. Each school attending the center develops and implements a Community Learning Project, i.e., continuing contact/projects at their home schools and communities.

We propose a pilot Scientist-in-Residence pilot project to as an integral part of their existing AIR series for the 03/04 school years. The professional faculty of IW will directly collaborate with the cadre of researchers in our RA Program to work with 4<sup>th</sup> & 5<sup>th</sup> grade students using traditional scientific inquiry methods and non-traditional methods, specifically art-based research. The Scientist-in-Residence will also provide research guidance to the IW educational staff.

Research conducted during the Scientist-in-Residence week will be a part of an on-going research project to study the effects of human and natural disturbances on canopy biota using IW's existing suspension bridge and canopy tower. Research foci include: 3-dimensional systems moving through time; microclimate studies; canopy succession; and pollution studies using lichens as monitoring organisms. We anticipate that 2-4 of our RAs will choose this as an opportunity to disseminate his/her research. Each scientist in this pilot project will live on site for one week (meals, lodging, and honorarium provided). IW's vision is to link this program with their AIR, thus creating teams of artists/scientists who work

alongside students to model the investigative process as it is explored in the individual disciplines. As they integrate arts and science, they hypothesize that the boundaries of both disciplines will meld synergistically. This pilot project will allow IW to test these concepts and structures.

#### *VI. B. Formal Science Education*

We anticipate at least three ways by which the proposed work will interact with formal science education. RAs may choose to make contacts and give talks to youth in a formal school setting. In my own experience, this has been an effective way of directly influencing children. Canopy studies in particular represent exciting methods and content for young children. Giving tree-climbing demonstrations in the schoolyards or slide shows with tropical forest organisms provides an exciting window, especially for 4-6<sup>th</sup> graders. These subjects fit with curricula at that grade level (e.g., rainforests, ecology, geography).

Second, RAs who serve in the Scientist-in-Residence program of IW (see above) could efficiently and productively provide presentations at the schools from which IW draws its students after they return to their home schools.

In the future, we may be able to fold in our dissemination with ongoing efforts at Evergreen to improve math and science programs. A large proposal is pending with NSF for a 5-yr project to improve the math and science programs (MSP) of 29 middle schools in partner school districts (Fig. 2). If funded and implemented, the project would directly impact 400 middle school teachers and 51,000 students. Our future connection would be through communication of RAs in teacher training, and potential after-school and community-partnering activities.

### **VII. DISSEMINATION AND EVALUATION PLANS**

Our Evaluation consultant will carry out front-end, formative, and summative evaluation activities throughout the project. Initially, our evaluator will review in detail the preliminary work that has transpired with pre-Research Ambassador outreach activities (see Anc. Mat.). She will review the scientific work of each RA to explore potential connections. She will develop draft and final questionnaires for the RA, help organize the SPOT work, and analyze results. She will also develop pre- and post-exposure questionnaires and other evaluation instruments for representatives of each of the RA audiences. Finally, she will design, execute, and analyze an exit interview with each RA.

Our ISE consultant will provide general oversight throughout the project as well as the following three specific tasks: 1) work directly with our team to help RAs brainstorm and find appropriate “hooks” that would appeal to various audiences, especially youth; compile examples of effective communication products; provide links to the media, which is necessary to complete the circle of bringing the unaware to awareness and then action; and 4) explore having specific “big-time” media outlets (e.g., *Time for Kids*) do special pieces online and in print on scientists who communicate science.

### **VIII. PROMOTION AND SUSTAINABILITY**

All of the collaborators will be involved with the promotion of the Research Ambassador program. Individual scientists will include descriptions and outcomes of their efforts whenever they give talks in professional settings. Our presence on the world wide web will attract people who search the web whom we do not speak to directly. Our collaborating institutions, especially the National Geographic Society, will be extremely important in communicating about the program through their many media outlets.

Although this initial step of establishing a Research Ambassador program requires funding, opportunities exist for some of this outreach work to pay for itself in the future. For example, some of the hobbyist and trade groups are able and willing to pay honoraria to visiting lecturers, and many popular publications pay modest sums for articles. Additionally, our collaborating institution, ICAN is a non-profit organization that accepts tax-deductible funds from individuals, foundations, and special interest groups. In the future, the RA program could be at least partially supported by such contributions. Part of our assessment work will be to explore other pathways of sustainability.

## **IX. ANTICIPATED RESULTS**

### *IX. A. Immediate and Short-term Results*

At the immediate level, the establishment of the Research Ambassador Program will result in the training of a minimum of six scientists to effectively communicate their work beyond their academic audiences and disseminate their research to non-scientists in a variety of modes. They will garner the tools to identify non-traditional audiences, gauge the level at which to speak and write, accrue tips to make effective graphics, and acquire (or have assistance) establishing or modifying a website that appeals to a lay audience. Our team will also examine, document, and communicate the process of this translation, and the reactions evoked from other scientists and communicators to expand this program in the future.

In terms of numbers, I anticipate that each RA will speak directly to a minimum of 40-100 people (e.g., 1-2 civic groups or classrooms). He/she will also write at least one popular article, which will be read by 12,000-40,000 people, according to the distribution of the magazines. We anticipate that our work will have impact in three areas: outreach to canopy studies and ecology, informal science education, and formal education.

IX. A. 1. Outreach About Canopy Studies and Ecology: This project will help inform sectors of the general public about canopy studies, an emerging subfield of forest ecology (Lowman & Nadkarni 1995). The increased understanding of the forest canopy is just now being integrated into our knowledge of forest ecology and management, and our activities will enhance this trend. Our work will also provide models that can be used by other fields of ecology.

IX. A. 2. Informal Science Education: This project will test the extent to which researchers can become involved in ISE. We can explore the ability of scientists to overcome communication obstacles, and determine which of the array of incentives work and do not work. Collaborations with consulting ISE practitioners will ensure informed ISE work. Results will be critical in informing future work on an expanded Research Ambassador program.

IX. A. 3. Formal Education: This project will have an impact in educating the next generation of ecologists with the ability and willingness to disseminate their own research in addition to collaborating with ISE people. I teach 75-150 undergraduate and Master's ecology students each year, and always include exercises in research dissemination. The undergraduate and graduate students involved with this program will gain experience with all aspects of outreach and scientific communication, particularly in the interface between science and media.

### *IX. B. Projected Broader Impacts of Proposed Work*

We foresee three larger-scale outcomes of this pilot project. First, the assistance our team provides help to the six scientists who will disseminate information about subjects ranging from forest canopy structure to invertebrate biodiversity in a wide range of non-scientific settings. Based on previous experiences, the talks, articles, and associated websites we create will spread the information to many other venues and people through the "leapfrog effect" of associated networks.

Second, the positive feedback received by this pilot set of RAs will result in direct visible reinforcement for recruitment of other scientists as this program expands. The approach our team tests here expands the existing repertoire of ISE approaches. It will complement the traditional ISE approach of supporting a small number of large ISE institutions that attract mainly scientifically active and scientifically aware audiences with educators or media people as the primary communicators. The Research Ambassador program will lead to a "grassroots movement" aimed at scientifically unaware audiences, with scientists as the primary communicators. This project could become a model for scientists for many disciplines to become more directly involved in outreach activities of their own research, and to reach audiences that have not been previously well-served by traditional ISE pathways.

Third, the connections across disciplines that we will make by providing RAs with a “hook” to engage the scientifically unaware public is a key to exploding the way scientists, non-scientists, and educators have viewed each other. People tend to think in boxes, whether they are scientists, pest exterminators, or bankers. We will assist scientists to find creative and innovative connections, such as linking biological diversity to human diversity in the workplace, nutrient flows and cash flows, healing trees and healing humans. These are old connections, using nature as a metaphor for understanding ourselves and our roles in the world, but one that is currently fading from consciousness as our refernces are increasingly media-based and urban.

Thus, this pilot project – six scientists delivering information on forest canopy and related ecological studies - can serve as examples for other scientists who are interested in outreach work, and for other communicators interested in science. This work will initiate a new approach for informal science education.

#### X. TIMELINE

May 2003	Hire staff; recruit RAs, establish website, develop evaluation tools
July 2003	Entry interviews, SPOT team visits RA labs & field sites
September 2003	Make contacts for RAs, generate websites
Nov.-Jan. 2003	RAs carry out talks, write popular articles, augment websites
March 2004	Exit interviews, assess process, modify websites
May 2004	Evaluation of RA program, recommendations for future activities

#### XI. RESULTS FROM PRIOR SUPPORT [full citations are in References Cited section]

**Nadkarni, N. & J. Cushing: BIR 93-07771 (1993-1995), BIR 96-30316, BIR 99-75510 (1993-2003): The analysis of three-dimensional spatial information of tree and forest canopy structure (Database Activities Program & Ecosystems).** Our team of canopy researchers and computer scientists were awarded a Planning Grant to establish methods to collect, store, display, analyze, and interpret 3-D spatial data relating to tree crowns and forest canopies. We established an e-mail bulletin board, quarterly newsletter, directory, and citations database on canopy studies. We created the International Canopy Network (ICAN), a self-sustaining non-profit organization, to continue these activities. This led to development of database tools and a metadata database to understand forest canopy structure/function relationships in eight forest sites in the Pacific Northwest and with collaborating researchers. The grant resulted in seven scientific papers and two websites (see References Cited).

**Nadkarni: DEB 99-77435 (1999-2003): Effects of disturbance and global climate change on tropical cloud forest canopy communities: an experimental approach (Ecology & Ecosystems):** I drew from my NSF-sponsored research to quantify pools and fluxes of biological, physical, and chemical properties of organic matter held within the canopy and compared them with organic matter on the forest floor in Monteverde, Costa Rica (**BSR 87-14935, BSR 90-18006**). We carried out experimental studies involving transplant experiments to assess potential effects of global climate change on epiphyte microcosms and carried out measurements of nutrient cycling and phenology at a landscape level in pristine and agricultural settings. The grant resulted in 13 scientific papers, one book, and two chapters in encyclopedias, and a website (see References Cited),

**Nadkarni: DEB 96-15341 (1996-1999): Enhancement and dissemination of long-term datasets on tropical montane forest nutrient dynamics in Monteverde, Costa Rica (Long-term Research in Environmental Biology).** I focused on long-term aspects of canopy and forest dynamics research in Monteverde. The research team re-measured our permanent plots to determine growth and death rates of

host trees; measured epiphyte colonization and growth rates, quantified seed rain and seed banks of arboreal and forest floor soils; and made preliminary assessments of global environmental changes on epiphyte communities. I also created a web site for researchers. The grant resulted in four scientific papers and a website (see References Cited).