cess presented by an ESA researcher; and (c) a reception for informal discussion with present and past Program Directors and Panel members. All members of the Society are invited and encouraged to attend.

There are several ways in which our Society and our sister societies through the Liaison Committee can be of assistance to NSF, including:

a) ensuring that there are always a number of strong candidates for the rotating program directorship, and for members of advisory panels,
b) writing constructive ad hoc reviews of proposals,
c) providing testimony at appropriate times during the budget process,
d) helping to formulate new initiatives and longer range research priorities and strategies, and
e) making certain that as a Society we are well informed about NSF programs and plans.

During the coming year, the Liaison Committee and the Public Affairs Committee will further develop these ideas and establish formalized mechanisms for conveying information to NSF. If you have thoughts or suggestions, please let us know.

ESA Subcommittee of the
Research Support Liaison Committee
in Ecology, Evolution, and Systematics

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SOME ADVICE FOR GRADUATE ADVISORS

Perhaps half of the difficulties encountered by graduate students derive from interactions (or lack of interactions) with graduate advisors. All advisors have the benefit of insights from their own experience as advisees, but sample sizes of 1, 2, or 3 may not provide much insight into the intricate details of good advising. Therefore, a discussion of the proper role of advisors is a logical follow-up to recent advice given to graduate students (Huey 1987, Stearns 1987).

Initial Premise: Graduate Students are People

Graduate students can be described by models identifying their many functional and structural roles in research labs, field projects, classrooms, and budgets. However, the most encompassing model of the nature of a graduate student is the humanistic model, encompassing submodels of both physical and psychological well-being. Given this premise, a long list of corollaries can be developed.

Graduate Education = Personal Development

Graduate education is a major step on the staircase of personal development. It has a beginning and, one hopes, an end, but is only a single stage in a longer sere. The graduate advisor can have a large influence on physical well-being by supplying the requisite financial resources, and on psychological development by caring enough to consider the ideas discussed below.

Care about Students

If you don't care about students, you should not agree to serve as anyone's major advisor. You won't enjoy it, the student will be handicapped, and if cosmic justice prevails, your career will not be advanced. If you care, then take the time to think about how you can do a better job.

Provide Clear Maps

The territory of graduate studies has been traversed by thousands of students, but it's a novel experience for each beginning graduate student. The advisor can be of enormous help by providing a clear map of the territory. Such maps come with several overlays.

Each institution has a unique list of hoops each student must pass through, including requirements for coursework, minors, languages, exams, and the dissertation. Most schools and departments have clear guidelines, but some don't. In all cases, advisors should go over the task map carefully with the student at the beginning of the program, or perhaps even during the negotiation phase the spring before.

The task map overlay needs to include clear expectations of the time for reaching each milestone. The time estimates of course need flexibility, but a clear acknowledgment of the modal time requirements can serve as a reassuring measure of progress, or a warning of growing resistance to progress.

Naive students may expect the maps of tasks and times to explain the framework of their graduate program, but there are hidden dimensions that are obvious to advisors that need to be pointed out. Examples include: interests and personalities of prospective committee members; how to prepare for comprehensive exams; and the need to publish as soon as possible. Insights may be especially helpful on how to develop a healthy and humble professional ego in the face of all the competition and ego games among peers.

The reasons for selecting or omitting specific courses are not the same as in undergraduate territory, and the selection criteria need to be discussed explicitly. Graduate courses (beyond those required by the department) need to be selected on the basis of:

- Filling in critical gaps in the student's knowledge
- Subjects that are difficult to master by independent study (such as biochemistry)
- Formats that involve reading and critiquing current literature

Help Develop Writing Skills

Most graduate students enter their programs with a fair command of English (with the exception of some foreign students), but very few have much experience with science writing. The types of writing courses offered to undergraduates probably provide little insight into science writing. Therefore, it is up to advisors to see that the graduate student is provided with the opportunities to learn to write. In addition to directing them to the usual writing manuals, there are two basic components:

- Provide careful, detailed, and encouraging comments on the student's manuscripts (including many papers before the final dissertation). This can be very time consuming if done well, but is probably one of the most useful tasks an advisor can perform for a student.
- Provide opportunities for the student to critique other manuscripts, including your own and those sent to you to review by colleagues.

Make Thesis Research a Pleasure, not a Terror

The nature of the thesis or dissertation undertaking needs to be clearly communicated to the student. Statements of objectives like, "to make an original contribution to the body of science" can be imposing and worthless. Be clearer. Give reasons such as these, or your own version of these:

- To have your first major experience with performing research be under the tutelage of a great advisor.
- To learn how a research project is conceived, developed, and executed.
- To convince possible employers that you're a better candidate than your competitors.

With these objectives clearly in mind, the graduate student should be well on the way to a positive thesis experience.

Encourage Career Diversity among Students

Keep in mind that the careers of few students follow precisely in the footsteps of their advisors. Be sure students are aware of the wide array of career paths that are open to them, including industry, consulting, and non-university teaching.

Encourage (and Fund) Participation in Conferences

Graduate education prepares students to become peers in a scientific community, and the sooner the student begins to fledge, the better. Attending conferences, presenting papers, and dealing with fellow scientists one-on-one is critical. Take the time to introduce the student to important people with similar interests. I know of no recent graduate who landed a top-notch position upon graduation who was not already well known in the ecological circle of his or her specialties.

Provide a Map of the Adult World of Grantsmanship

The final map a graduate student needs is the one most often omitted—how to compete for research funds. Let them read your proposals (both successful and unsuccessful), along with the reviews you received. Insist their thesis proposals be written as though they would be submitted to a funding agency, and see that the proposals receive several reviews from fellow students or professors. If possible, involve them in your current proposal writing. (If you are not active in seeking research funds, be sure your students spend time with committee members who are.)

Manage Your Students

Some advisors take a hands-off approach to Ph.D. students, using the sink-or-swim philosophy of letting the student do the entire program as though he or she were already a fully fledged scientist. If this is the sort of advisor you are, never take on a graduate student who does not yet have a Ph.D. Be an active participant in the student's development; tread the fine line between encouraging independence and providing assistance. The optimal amount of assistance, of course, varies with the student, so the best strategy is to discuss this topic periodically in the student's program. Is progress satisfactory? Are there any major stumbling blocks? Does the student need help in setting schedules?

Perhaps the best advice in this category is simply to keep abreast of what the student is doing on a regular basis. This involves having a written plan of study that covers the entire degree program, and frequent updates on current performance (including occasional written progress reports). Remember what's been discussed at these update meetings; few things discourage graduate students as much as an advisor who doesn't remember what was discussed in a conversation a week or a month earlier. (Hint: take notes.)

Be Available for Cosmic Discussions

Much of a graduate education occurs outside the formal structure of courses and thesis research. An advisor who is readily available for discussing ideas wildly unrelated to narrow thesis subjects is a gem. Other graduate students also serve this role, but they can't take the place of an accessible, interested advisor. Take students to lunch—they're poor, they'll appreciate it, it's more fun than eating alone, it doesn't cost much, and can help on taxes.

Encourage Multiple Projects

The dissertation should be the cornerstone of the graduate program, but smaller side projects can add a lot to the structure. They provide diversity in subject matter, opportunities for creating more than one set of hypotheses, and a chance to work on research with other students or professors. Perhaps best of all, small side projects can provide the advisor with answers to small questions that he or she has always wanted to explore but never had the time.

Involve Them in Your Consulting

If you are involved in consulting, your students should have the opportunity to benefit from your diverse activities. Active participation can help them become acquainted with other professionals in the field, provide learning opportunities, and perhaps funds to supplement meager stipends.

Involve Them with Visiting Colleagues, Interviewing Faculty, etc.

This might seem self-evident, but I have heard of many students who have missed the chance to interact with visiting scientists because their advisors didn't think to include them. This is again important both for education, and for developing the professional contacts that are a part of being a full member of a scientific community.

Encourage Them to Work Independently with Other Scientists

If you're a good advisor, your students will assimilate much of what you have to offer long before graduation rolls around. They will learn more if they associate independently with other scientists, and will perhaps be less disillusioned when they realize the limits of your own knowledge.

Discuss these Ideas with Prospective Students

If you discuss these ideas, along with those of Stearns (1987) and Huey (1987), with prospective students, you will have a chance to come to a mutual understanding of expectations, as well as a foundation for evaluation of the student's performance as a budding scientist and your performance as a mentor.

Literature Cited

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CONSERVING TROPICAL FORESTS THROUGH LOCAL ACTION ON RECYCLING

As ecologists we all deplore the loss of biological diversity predicted by Myers (1979), Ehrlich and Ehrlich (1981), Caufield (1984), Wolf (1987), and others, as a result of the fragmentation of tropical forests by the hand of man. All of these authors make the case that much of the pressure on these forests is a result of the profligate use of natural resources by developed countries, particularly the United States, coupled with the ridiculous practice in our "throw-away" society of burying solid wastes in sanitary landfills rather than recycling reuseable materials.

Right now in the United States, as a result of a combination of factors but mostly because half of the landfills in the U.S. will be full by 1990, and because land is too expensive to make it worthwhile to continue using it for landfill (Pollock 1987), there is a need to start local programs for handling municipal solid waste (MSW). There are three alternatives in most situations: (1) mass incineration, (2) complete recycling, and (3) a combination of recycling and incineration.

Mass incineration reduces the volume of MSW by ≈90% by burning all of it, leaving only the ash residues to be sent to a landfill. Mass incineration is usually coupled with waste-to-energy schemes whereby the heat produced in the incinerator is converted to a useable form of energy (usually electricity) which is then sold to a local customer. Although mass incineration is thus capable of partly paying for itself, it has hidden environmental costs not normally considered by its engineering advocates. Specifically, because chlorinated benzenes and chlorinated phenols (present in some plastics) are burned, dioxin is produced (Shaub and Tsang 1983), and because consumer metals are burned, heavy metals are ultimately left in the ash residue that is then taken to a landfill (Yakowitz 1983). Hence, mass incineration of mixed MSW is a "quick and dirty" solution that does little to alleviate the pressures on tropical forests because it does not remove and recycle useable materials.

Complete recycling potentially reduces the volume of solid waste to nothing (although in practice bulky and inert materials may still go to landfill) by separating the mixed MSW into its components—usually aluminum, ferrous metals, glass, paper, plastics, other specialty metals, and a large (70–80% by mass) organic component. All of the reconcentrated materials (except the organic component) are then sold to available customers; the organic component is typically composted and then sold (or given to local taxpayers) as a useful soil amendment. While complete recycling has no