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February 18, 1998

Marsha L. Landolt
Dean,
The Graduate School
University of Washington
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RE: Response to the Review Committee Report

Dear Dean Landolt:

Enclosed is the QERM faculty response to the committee report on the review of the Quantitative Ecology and Resource Management graduate program. We look forward to the opportunity to discuss the report and recommendations with the Graduate School Council.

We also wish to bring your attention to the attached letter that has been included as Appendix I of our response. The MathBio Group and QERM are requesting your support in furthering the quantitative education of biology, ecology, and resource management graduate Students at the University of Washington.

Sincerely,

E. David Ford
Professor and Chair,
Interdisciplinary Graduate Program in
Quantitative Ecology and Resource Management

EDF:jmb

Enclosure

c: ✓ Elizabeth L. Feetham
Associate Dean for Academic Programs

**Interdisciplinary Graduate Program in
Quantitative Ecology and Resource Management**

***Response to Comments Made by the
Ad Hoc Review Committee***

February 1998

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I. EXECUTIVE SUMMARY

1. The archetypal graduate of QERM finds first employment in a natural resources agency or university research team as a team member with quantitative responsibilities or forms their own business before moving to more senior positions including university professorships. QERM must ensure that graduates can fulfill the duties of such positions.
2. We do not propose to change the principle of our degree structures, particularly the qualifying year which the Review Committee suggested we consider. This is essential to sustain the quality of our graduates, and to maintain the reputation of the program.
3. We are enthusiastic about developing a course specifically to provide a transition from the qualifying year to research education in ecology and resource management. A graduate course in this subject will attract students from other programs.
4. In our strategic planning we will:
 - [A] Continue to work for wider faculty participation in the program.
 - [B] Work with the Mathematical Biology group (MathBio) to develop the quantitative environment for graduate education in biological and environmental subjects.
 - [C] Collaborate with the Program on the Environment (PoE) in developing their graduate program.

The move to upper campus, in close association with the National Center for Research in Statistics and the Environment and the Program on the Environment will greatly assist this.

5. At the suggestion of the Review Committee we have already improved the modeling arm of the QERM program. (See details in our response).
6. Review Committee suggested CQS and QERM should be reunited. We have developed an understanding with CQS to ensure stability of high quality TA support for CQS courses.

II. INTRODUCTION

Since receiving the report of the Ad hoc Review Committee for the QERM Interdisciplinary Program we, the faculty, have held three meetings, and an additional meeting jointly with the QERM students, to consider our response. We are grateful to the Committee, and for the review process as a whole, for raising important issues and encouraging us to consider new approaches. We are particularly pleased that the Committee:

"...found the QERM Program to be of exceptionally high quality, to be an important contributor to the mission of a variety of other academic units on campus, and to have tremendous potential to continue training top quality graduate students".

The Review Committee Report raised important general questions about the balance within the program. Consequently, we review briefly our academic objectives, leading to how we might meet some of the committee's suggestions without sacrificing our strengths. The Committee also made specific recommendations and we make an itemized response to them. We also respond to the letter sent by Deans Nowell, Simpson and Thorud to Dean Landolt with their comments on the Program and its review.

III. REVIEW OF ACADEMIC OBJECTIVES

Every program in the broad areas of the environment, including the management of resources and ecology, has its own emphasis. Our emphasis is on quantitative modeling and analysis. The focus in QERM is the successful integration of three subjects.

- (1) applied mathematics and modeling,
- (2) statistics, and
- (3) ecology and resource management.

The Review Committee emphasized the integration as between two: quantitative, (1) plus (2), and ecology and resource management (3). However, the integration of (1) and (2) is a unique aspect of our program: applied mathematics and statistics programs are markedly different in their approach to scientific questions yet both must be understood by our students. Our graduates achieve a synthesis of the **three** subjects. They understand the dimensions of natural resources and ecology problems, can make effective decisions on how quantitative analysis should be carried out, and can carry out the work technically.

The approach to integration of this interdisciplinary subject must take account of the requirements of graduate education. In the mathematical sciences there should be qualifying, general, and thesis stages, each assessed by an examination.

In QERM, the focus of the qualifying stage is two-fold. Students are provided with:

- a. the technical statistical and mathematical modeling tools they must master in order to undertake quantitative work in ecology and resource management, and

- b. exemplars where instructors pose a series of typical quantitative ecological or resource management questions, and illustrate how they are analyzed.

Currently the required courses for the qualifying examinations are:

Autumn Quarter

QERM 550 (4) Applied Ecological Modeling.
STAT 512 (4) Statistical Inference.
QERM 598 (2) Introductory Seminar.

Winter Quarter

ZOOL 470 (3) Techniques for Mathematical Biology.
STAT 513 (4) Statistical Inference.
Required seminar selection.

Spring Quarter

ZOOL 471 (4) Models in Biology.
QERM 514 (4) Analysis of Ecological and Environmental Data.
QERM 598 (2) Seminar presentation of senior QERM students thesis work.

QERM qualifying examinations, one theory and one applied, come at the end of the first year of study. All students, whether aiming for Masters or Ph.D. take the same core courses and examinations.

Although the Review Committee apparently felt the qualifying year overemphasized the quantitative at the expense of ecology and resource management we feel this curriculum provides an essential foundation upon which students can build to achieve the desired synthesis. Interestingly, the integration between statistics and applied mathematics/modeling can cause more difficulty for students than that between those two quantitative subjects and ecology and resource management. But until students have made that first integration they are not qualified to proceed to their research.

A wider and deeper integration occurs during the general stage, and of course during the thesis work. As in all graduate programs these stages are governed by the students' committees and advisors. The QERM program encompasses students both from mathematical and from ecology and resource management backgrounds. During their general studies students with strong mathematical or statistical backgrounds tend to take electives in ecology or resource management, while those from ecology tend to focus on developing their quantitative skills.

Should we, and could we, teach more ecology/resource management in the first year, as suggested by the Review Committee, and include that in the qualifying examination?

- (a) Ecology and resource management are diverse subjects, and QERM students enter the program with diverse ecological and resource management experience and interests. Instituting an ecology or resources management section of a written QERM qualifying examination would require a course work focus not currently found in University of Washington.
- (b) Assuming an agreed selection of course work could be made, adding ecology and resource management to the qualifying requirements would mean either extending the time to the qualifying examination beyond the first year, or replacing some

section of the present core curriculum. In 1992 we discussed proposals on these lines: these proposals were defeated by a large majority (16-2).

The faculty feel that our focus and level of integration are correct for the qualifying stage.

The Review Committee commented on the qualifying stage:

"While some students thrive in this environment, the Committee learned that over the years, many students have been daunted by these strict requirements and that, in some years, the entire first-year class has submitted petitions to the administration suggesting that the requirements be changed. ... Many students stated that they would prefer to take biology-related classes earlier in their graduate careers, but that the intensity of the mandatory quantitative courses and qualifying examination preclude this."

Both a correction and an interpretation is needed. Though many students have had concerns, the one year that the students did petition collectively concerned the modeling sequence—that it was not of the same standard and value to the program as the statistics sequence STAT 512/513. Faculty agreed with that (see discussion in the self-study document) and recently we have been able to replace CIVE 491 with ZOOL 470/ZOOL 471. ZOOL 471 comprises 5 two-week long examinations of modeling examples, three ecological and two other using valuable modeling techniques. This will round out the taught exemplars and develop students' technical skills much more effectively than in the past. Also, for the first time since the late 1980's, we have stability of instructors in QERM 550 so the modeling arm is now comparable in quality to the statistics arm.

These are definite improvements in how the qualifying year will be taught. Nevertheless the concerns described to the committee about the toughness of the qualifying year, and its particular form need to be answered. The faculty have discussed this extensively, with the following conclusions:

1. The synthesis made, where problems and how they are analyzed is presented as a series of exemplars, is the correct one for the QERM qualifying year. The statistics theory qualifying examination is essential.
2. The breadth of ecology and resource management subject matter does not lend itself to a program wide qualifying examination neither as a subject in itself, nor in relation to the diverse student interests. Even in programs specializing in these subjects the examination is left to the student's committees and narrowed to the students individual interests and these are not program wide qualifying examinations. In QERM, as in other resource management and ecology programs, examination of this knowledge is appropriate at the general level and focused around a research oriented specialty.
3. The standard of the qualifying examination is tough—and the senior students appreciate the foundation it provides. Our graduates find positions as quantitative team members in resource management or ecology agencies and research projects, or actually become independent consultants. This is a remarkable achievement illustrating the confidence that a QERM degree gives, including the M.S. degree. We must have our graduates prepared for this work.

However, we plan to do the following in response to the Committee's comments:

1. We will describe to the students in the first year the academic journey they are on and what the end point may be. Accordingly we will change the emphasis of our Autumn Quarter QERM 598 seminar to include visits by renowned alumni to present the work they do.
2. We will take our explicit instruction in the integration of the three component disciplines further than the qualifying year and beyond the use of exemplars. Accordingly we will introduce a required course for all students to be taken at the start of their second year in **the scientific method**. This will be a section of QERM 521, already taught to Fisheries and College of Forest Resources Ecosystem Analysis graduate students. It will be team taught and examine ecology and resource management and its quantitative issues starting from the open ended perspective of the applied problems. This course will be integrated with the production of a research plan by students with RA support or with lab rotations and will lead to work for the Masters bypass for some students. Preliminary discussions with faculty in other programs indicate that this course would be of interest to some quantitative students in Fisheries, Economics and Forest Economics graduate programs.

A second important issue is mentioned by the committee.

"The more biologically oriented students who enter QERM often flounder and require an extra year because of the heavy quantitative requirements and they may never get up to speed. ... (T)he requirement that students take and pass the qualifying exam after the first year means that only very quantitatively adept students are likely to succeed, and this might be deterring some of the more ecologically minded applicants and hence might be driving the very nature of the students who enter the program."

There are some points of emphasis to be corrected in these comments and we must report explicit attempts we have made to bring students who did not have a primarily mathematics training into the program.

First, the students do "get up to speed" otherwise they do not pass the qualifying examination.

The faculty feel it is valuable to bring students into the program, not solely on the basis of their previously acquired mathematics skills, but on the basis of their interest in the program, and their potential to succeed. We have accepted students into the program who did not have extensive undergraduate course work in mathematics but did have high GRE scores in Quantitative and Analytical categories (over 750). Some of these students really have done well in the usual program passing both examinations at the Ph.D. level at the first attempt. Others were brought into QERM with the explicit understanding that they take a year of prerequisites: these prerequisites were discussed when places were offered and the students were happy to come because they appreciated they were re-tooling their academic competence. However, as much as we might wish to help students in an educational conversion, we cannot sustain the financial burden this imposes. Currently, advice is given to the many potential applicants who wish to come to QERM from non-mathematical backgrounds to take the mathematical prerequisites before applying and some do so.

We will continue to bring students into the program who have no previous mathematical training but who have high Quantitative and Analytical GREs, and who wish to develop mathematical competence via an extra year of prerequisite course work. In conjunction with the Mathematical Biology program we have written to the

Dean of the Graduate School seeking her support to approach the Development Office to pursue such funding (Appendix I).

IV. RESPONSE TO SPECIFIC RECOMMENDATIONS OF THE REVIEW COMMITTEE

1. A Strategic Plan.

We are pleased that the Review Committee drew attention to the need to put QERM on a stable footing for space and resources. The Graduate School has allocated us additional funds so that we can now support the QERM courses effectively.

There are two components to our strategic planning. First, as an interdisciplinary graduate program within the Graduate School we contribute actively to the School's strategic plan. Second, we plan with regard to our academic mission and how this might evolve in the future.

QERM has evolved from the QE option of the Biomathematics program over a 10 year period. Considerable change was made during that evolution to adapt to major changes in the intellectual tenor of the U.W. campus. We are still following possible ways in which further evolution can take place.

It is essential that we build on our strengths. We know that QERM is very healthy academically with excellent students, high standards, and a clear purpose. We have more than achieved the goals we set in 1990. We have gone through major upheavals in the last two years with the total change in CQS which the 1990 Review Committee saw as our academic parent, and demolition of the building in which the program had been successfully housed. QERM needs time to digest this and the new procedures we outline above which will develop our strengths still further. In our strategic planning we will focus on three potential developments.

- [A] Developing QERM masters programs for Ph.D. students in ecology and resource management programs. In the past some Ph.D. students, e.g., in Zoology, Fisheries and Forestry, did Masters in the QE option of the Biomathematics Program. We plan to make this more possible in the future.
- [B] Working with the Mathematical Biology group (MathBio) to develop the quantitative environment for graduate education in biological and environmental subjects. MathBio is a graduate training program funded through the National Science Foundation and awards training grants, normally two quarters in any academic year, to students in any graduate program at U.W. NSF funding for MathBio will end in 1999 and the program is not eligible for renewal. QERM will work with MathBio to sustain and develop this graduate education by obtaining funding from other foundations. See letter from Professors Daniel, Thompson and Ford, Appendix I.
- [C] Collaboration with the Program on the Environment (PoE). Currently PoE is engaged in developing its undergraduate major but it intends to consider a Masters degree. We anticipate being part of the discussions on that. We will share space with PoE until it moves to Mary Gates Hall.

2. Program flexibility.

Our proposal 1[A] above is designed to encourage students to start by going into ecology and resource management and then move towards quantitative study. We have discussed the role of the qualifying examination previously in this response.

A non-thesis masters option is not appropriate. Essential parts of the interdisciplinary synthesis are driven by the needs of the student's thesis topic and that can not be replaced by course work alone. However, we will streamline the Masters Bypass. The additional course intended for 2nd year students will assist the transition into research through more directed integration of quantitative and ecology and resource management.

These initiatives demonstrate flexibility, and particularly will help us educate more biologists wishing to develop mathematical skills. This is more possible now that QERM is clearly administered through the Graduate School and physically located on upper campus.

3. QERM's potential is not being fully utilized.

We sought clarification from Dr. Woods, Chair of the Review Committee about what precisely was meant by these comments. With regard to **QERM students not being trained to be independent scientists** it seems that the committee were concerned that student's research was being conducted in teams. The faculty of QERM consider that is a good thing and, if the student has quantitative responsibility within that team that is excellent.

This comment is the one the QERM faculty spent the most time over. Every way that we examined it, we came to the conclusion that it is not accurate. That we encourage students to work in teams is absolutely true. Astoundingly little contemporary science is done sitting alone in a laboratory or office, from physics to ecology, it is done as a team effort where individuals' results are synthesized to make a coherent whole at the research project level. However, the ability to do independent work to hold up one's responsibility to a group is also critical. Thus, we do **not** in any sense, encourage or endorse cooperative theses or dissertations. Work must be unambiguously identified as being done by the student getting the degree. It would not be possible to identify any case where it is otherwise.

Furthermore, that we can identify at least two new and successful companies formed by our graduates, while students, is a form of testimony to their ability to work independently. We can also identify Biomathematics and QERM Ph.D.s who have taken faculty positions and are successfully doing independent research.

We know that our students are worthy of their Ph.D. degrees. The best independent evidence comes from the comments made by Graduate School representatives on QERM student committees. From the records so far made available by the Graduate School at the General Examinations, 3 students were rated excellent (with two singled out for special comments), 2 above average, and 3 average. At the thesis examination 3 students were rated excellent and 3 average.

4. Shoring up the modeling arm of the program.

Since the Review Committee met we have made major progress. The first year modeling sequence now comprises:

- QERM 550 (4) Applied Ecological Modeling.
- ZOOL 470 (3) Techniques for Mathematical Biology.
- ZOOL 471 (4) Models in Biology.

Students will now gain extensive skills in the application of a range of mathematical techniques to applied problems, technical competence in Mathematica, and develop understanding of how models can, and should, be used in ecology and resource management.

5. A student handbook.

There has been a handbook for a number of years. It is now on the WEB. The main student concern has the introduction of the requirement for a Master or Masters Bypass research project prior to proceeding to Ph.d. research. The new section of QERM 521 will give students more direct help in meeting this requirements.

6. Establish an annual retreat.

This will be done specifically in relation to the development of our strategic plan.

V. RELATIONSHIP WITH THE CENTER FOR QUANTITATIVE SCIENCE

The Review Committee suggested that the UW find a way to reunite QERM with CQS, at least at the level of designating teaching assistants for CQS courses to QERM students.

The intent is to provide support for QERM students until they obtain RA support. Toward this end, the two directors have met and additional discussions have taken place with faculty in both programs. It is recognized that CQS is under the administrative auspices of the Office for Undergraduate Education (OUE) and that QERM is under the auspices of the Graduate School, two quite different administrative lines. Furthermore, the CQS program is expected to support graduate students from the resource colleges of Fisheries and Forestry, from where all of the faculty are drawn, as well as from other quantitative departments in the university. The fact is, however, that QERM students will continue to be amongst the most competitive for the higher level classes offered by CQS.

In the last two years CQS has supported numerous QERM graduate students as TAs, and has even used senior QERM students as the primary teachers in some classes. This latter arrangement, due to CQS faculty retirements that had not been replaced, is not a long term arrangement. Nevertheless, it does illustrate the high regard in which QERM students are held. The two directors will continue to meet to build upon the existing good relationship between QERM and CQS.

To make QERM students further attractive as TAs for any department on campus:

1. QERM will develop a TA training course, QERM 531, that will welcome all of the TAs for CQS classes, regardless of their academic program. The course will be offered by Professor Conquest in conjunction with CIDR each Autumn quarter.
2. A teaching requirement will be introduced into the QERM program and QERM 531 will become a required course. There will be alternative ways of fulfilling the teaching requirements, including past experience as a teacher or a TA position in a program other than CQS.

VI. ITEMIZED RESPONSE TO OCTOBER 3 LETTER FROM DEANS SIMPSON, THORUD AND NOWELL TO DEAN LANDOLT

1. The Deans interpret the Review Committee as suggesting that QERM lacks "a sense of academic direction and integration into the academic environment of the U.W." The review report does not say this. The report congratulates QERM on high academic standards, student camaraderie, and attracting many of the best applicants in this field because of its strong reputation. This is not achieved by a program with no sense of academic direction.
2. There is not a "lack of ecological training" for the QERM students. Some QERM students have up to two-thirds of their graded credit in ecology and biology courses. At the U.W. various graduate programs in ecology all chose an emphasis of some sort, and we have illustrated how QERM works in this respect. Certainly we can do more to make our interdisciplinary education more explicit and more complete. The newly proposed section of QERM 521 will be a valuable addition to graduate education for Forest Resources, Fisheries, and Arts and Sciences students.
3. The QERM faculty agree completely that faculty and students of a wider interest should be part of the program. We will continue to work to achieve this; at the same time there are important realities to consider. Faculty and students have to be attracted to the program and for this the program must have a reputation for high quality and neither intent nor appearance of competing with the potential faculty's home department programs. Our students are gaining the program a high reputation. For example, their regular involvement with the MathBio Program has impressed faculty involved with that program. Such reputations take time to develop in an academic environment. When QERM had to be relocated with the demolition of the CQS building, QERM faculty voted almost unanimously to relocate to a more central location specifically to broaden its involvement.

QERM can be successful as an interdisciplinary program if it continues to make its focus the application of high quality quantitative work. It must not be associated in a physical sense with any one group, nor must it be dominated by faculty from one college.

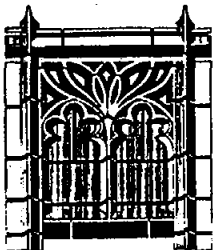
4. The Review Committee commented that teaching obligations and teaching credit should be made clear and "A procedure should be developed that rewards faculty for participating in QERM." Problems associated with teaching credit hours were resolved by the late Dean Carol Eastman.

The Deans comment: "The suggestion that a procedure should be developed that rewards faculty for participating in QERM is obscure." The need for such a procedure is not obscure to the QERM faculty. The Miles report on

Interdisciplinary Teaching and Research identified the lack of such a procedure as a specific impediment to the development of such activity. Some universities explicitly reward faculty for teaching involvement outside of their own department, school and college. This is not the case at the University of Washington.

5. QERM students and CQS TAs. The memorandum of understanding developed between CQS and QERM was developed following deliberations of the CQS Instructional Quality Committee.
6. The QERM program is neither isolated nor disconnected from ecology and resource management and it is specious to suggest that it is. Indeed, founders of the program were largely quantitative resource managers, biomathematicians and biostatisticians and thus the name of the program in the first place.

The QERM faculty has carefully studied the Review Committee's comments and recommendations. We found the review document of significant value in places and have already implemented some of the suggestions. Simultaneously, the report contained some factual errors and was occasionally cryptic. We are concerned that some of these errors will be remembered as correct. Nevertheless, we appreciate the difficulty the Committee had trying to understand the complexity of the administrative and academic associations while the program was in transition. What the QERM program most requires is time to implement the improvements we suggest.



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To: Dean Marsha Landolt, Graduate School.
From: Professor Tom Daniel, MathBio Group.
Professor David Ford, QERM Interdisciplinary Program.
Professor Elizabeth Thompson, MathBio Group and QERM.
February 13, 1998

Marsha Landolt
David Ford
Elizabeth Thompson

We write to request your support in furthering the quantitative education of biology, ecology, and resource management graduate students at the University of Washington. We are motivated by two events.

First, as you know the Graduate School Review Committee of the QERM Program recommended that QERM should consider providing quantitative education for students who start their studies with an ecological and/or resource management interest and orientation. While the QERM faculty have attempted this, with some notable successes amongst individual students, generally it is difficult to implement. We have found that most frequently such students require a preliminary pre-qualifying year in mathematics before they are ready for the QERM qualifying year. Despite there being some excellent students who could profit from such an education it is not possible for QERM faculty to fund this through RAships. An alternative is to provide support for more intensive mathematical training for graduate students presently enrolled in biological, ecological and/or resource management studies. Typically such students could take a Masters in QERM while studying for a PhD in, say, Botany, Fisheries, Forestry, or Zoology.

Second, the Mathematical Biology Program (MathBio), which has administered an NSF training grant for the past 8 years, is due to come to an end in 1999 and we have been informed that the NSF funding for this type of training grant will not be renewed yet we wish to capitalize on its success at the University of Washington. During its existence MathBio has supported graduate students from Botany, Genetics, Fisheries, QERM, and Zoology. The principal method of instruction by the program has been a year round seminar, held twice weekly, which is required attendance of all students receiving support from the MathBio Program. Typically a student presents their work at the start of the week, analysis is made, and the student returns at the end of the week with new ideas in response to questions raised. Currently more than a third of QERM students regularly attend these seminars even though not all are supported with MathBio funds.

We have two invaluable assets. The QERM program which brings a continuous stream of excellent students to the University of Washington and provides them with a rigorous, high education. The MathBio Program which has supported students in a range of graduate programs and provided a focus for the development and use of quantitative approaches in their research and general education. We seek your support in developing these assets to the general advantage of the University of Washington. In particular we would like to apply for foundation funding and seek your assistance in approaching the University Development Office. We would particularly like to develop scholarship funding for non-quantitative students to develop their quantitative skills.