

**Self-Study of the
Quantitative Ecology and Resource Management
Interdisciplinary Graduate Program**

**The Graduate School
University of Washington
Seattle, WA**

$$QERM = \int_{i=1}^{\infty} \frac{\left(\begin{array}{c} \text{Globe} \\ \text{Tree} \\ \text{Crab} + \text{Bird} \\ \text{Fish} \end{array} \right)}{\left| \nabla \left(\begin{array}{c} \text{Bird} \\ \text{Fish} \end{array} \right) \right|} d\text{Human}$$

*Quantitative Ecology & Resource Management
University of Washington*

Degrees Granted:
Master of Science & Doctor of Philosophy
Last Review: 1996

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*Quantitative Ecology and Resource Management
Interdisciplinary Graduate Program
2009 Self-Study Report
University of Washington*

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SECTION I. EXECUTIVE SUMMARY

The Quantitative Ecology and Resource Management (QERM) Interdisciplinary Graduate Program is dedicated to providing a course of study and research opportunities in the use of statistical, mathematical and decision sciences to a broad array of problems in terrestrial and marine ecology, natural resource management, biometrics and mathematical biology. The program makes a unique contribution by addressing these functions through a dynamic blend of faculty from various academic units, who provide access to diverse research opportunities and partnerships with many private and public sector agencies dedicated to the promotion of natural resource management.

The QERM program has been very successful overall in providing interdisciplinary education and research training at the interface of different disciplines. With strong quantitative and analytical training (median quantitative GRE score 775), and training in biology, ecology, and resource management, QERM students are well positioned for the world of work (our employment placement rate is essentially 100%). Our Ph.D. graduates who choose academia are also well positioned for work in quantitative ecology or natural resource management.

The success of the QERM program could be further improved by a more balanced mix of faculty from the two natural resource colleges and the Department of Biology. QERM has ample participation from the School of Aquatic & Fishery Sciences (SAFS). The College of Forest Resources (CFR) went a long time without new quantitative hires; CFR has recently hired at least three new quantitative faculty. One has recently joined QERM and others are considering joining. The Department of Biology has several renowned mathematical biology faculty who have not yet joined QERM.

The number of new graduate students admitted to QERM each year depends upon available fellowship funding. The coursework and qualifying exam preparation during the first year are intense. Beginning fall 2009, due to the (bleak) state budget picture, the number of graduate fellowships allocated to the QERM program from the Graduate School will be cut from three to two. We will receive a fellowship from the Hall-Ammerer Endowment (which funds interdisciplinary studies) in fall 2009, but there is no guarantee of this third fellowship in future years. If a qualified QERM applicant is clearly fisheries oriented, there is the possibility of receiving funding from SAFS, again not guaranteed. Ensuring an entering cohort of at least three per year is essential to the continued vitality of QERM.

One of the remarkable characteristics of QERM is that most students enter with fellowship support for one year, sufficient to support them during the intense first year of coursework and qualifying exams. They then always find support during their second year from faculty in areas from medicine to biology to the natural resource colleges.

We have been thinking of ways to provide a QERM education to scientists without the need for more entering fellowships. One pathway would be through a fee-based QERM certificate program (still in the discussion stage). Requirements for obtaining the certificate could consist of completing the first year coursework; passing the qualifying exams could serve as the capstone. This would require more administrative work for the Director and the Graduate Program

Assistant, but should not place an undue burden upon the core QERM faculty. A successful certificate program could also bring in outside funds for QERM.

As the QERM faculty continually review the availability and relevance of the coursework for QERM students, they will also have to consider the “demography issue”—namely, the “graying” of some key QERM faculty. QERM has recently recruited several faculty in the earlier stages of their careers. In the next five to ten years, QERM must make plans for orderly changes in leadership, for the teaching of certain QERM signature courses, and for continued student research support from QERM faculty, being mindful that we are a program with no faculty lines.

There is a symbiotic relationship with the Center for Quantitative Science (CQS) where teaching assistantships (TAs) are usually available for QERM students. Most of the CQS faculty (director Vincent F. Gallucci) are QERM members. Thus, QERM students have a good opportunity to obtain teaching experience.

Overall, the level of cooperation and support for QERM from the two natural resource colleges, and from the Statistics and Applied Mathematics departments, is very good. Both Statistics and Applied Mathematics welcome the presence of QERM students in their classes. The Acting Director of QERM during 2007-08 (while Dr. Conquest was on sabbatical) came from Applied Math. Regarding the two natural resource colleges, SAFS faculty have welcomed QERM students into their labs, and SAFS has even made its endowment scholarship funds available to QERM students pursuing fisheries-related research. Until recently, there have been fewer CFR faculty to advise QERM students, but with new quantitative hires in CFR, this situation has changed for the better.

SECTION II. ORGANIZATION AND GOVERNANCE

Quantitative Ecology and Resource Management (QERM) is an interdisciplinary program administered and funded by the Graduate School. The program brings together 30 active faculty (see Appendix C) and offers two graduate degrees, an M.S. and a Ph.D. (see Section III.D.). In this section, we briefly summarize the administrative organization of the program (see also Appendix A).

II.A. ORGANIZATION

The Program Director is appointed by the Dean of the Graduate School with the approval of the QERM faculty. The Director and the Graduate Program Assistant (see below) provide day-to-day oversight of the program. The Director chairs faculty meetings, is the Graduate Program Coordinator (GPC), supervises staff, runs the new-student orientation, meets with and assesses the progress of students in the program, approves student supervisory committees, is a member of the admissions and applied exam committees, and performs a variety of other administrative functions. Loveday Conquest, Professor and former Associate Director of the School of Aquatic and Fishery Sciences (SAFS), has been the Director of QERM since the autumn of 1999. Professor Conquest was on sabbatical during 2007–2008 academic year. During this time Mark Kot, Associate Professor of Applied Mathematics, was Acting Director.

The Director is aided by the Graduate Program Assistant (GPA), Joanne Besch. The GPA manages student-support, curriculum, administrative, and fiscal activities and serves as the primary contact and administrative link between faculty, current and prospective students, and the U.W. administration. The GPA, under the direction of the Program Director, develops and implements program enhancements and accesses campus services such as Computing and Communications, Registrar's Office, Curriculum Office, Development Office, the Graduate School, Payroll, and Publication Services. The QERM GPA is a 50% FTE position. Joanne Besch has been the QERM Graduate Program Assistant since February 1997 and has been at the University of Washington since 1983.

Overall the faculty provides planning and policy for the program. QERM has 21 core faculty and 9 affiliated faculty (see Appendix C). All QERM faculty may attend faculty meetings, but only core faculty may vote at faculty meetings (see Appendix H). A regular faculty meeting is held every fall. Other faculty meetings are held as needed throughout the year. Two faculty committees are crucial to the program; these are established at the fall meeting. Every winter, an admissions committee convenes to evaluate applications for admission into the program. Every spring, an applied exam committee convenes to write, administer, and grade the first-year applied methods examination (see Section III.D.2.). The Director typically chairs both committees. The composition of these two committees is determined at the fall faculty meeting.

Representatives of the graduate students attend the faculty meetings and provide feedback to the faculty.

II.B. BUDGET

Since 1996 QERM has received a guaranteed level of funding from the Graduate School. During the 2007-2009 biennium QERM received approximately \$76,147 annually. This funding covered a 9-month program director administrative stipend (\$500 per month), staff (50% FTE Graduate Program Assistant), and three 9-month graduate student appointments with tuition waiver;. The funds also covered operating costs (office supplies, phones, etc.), and a small discretionary budget (for recruitment lunches, meetings, etc.) (see Appendix B). Three 9-month graduate student appointments with tuition waivers have been funded annually. In addition, the program routinely requests \$20,000-\$25,000 each year in supplemental funds such as fellowships (Hall-Ammerer-WashingtonResearch Foundation Fellowship), recruitment incentives (ARCS Fellowship), travel for graduate student presentations at national and international meetings, recruitment travel, etc.

In recent years, we have received most of the funding outlined above. However, due to dramatic state budget cuts we will receive only two 9-month appointments annually effective in the 2009-2011 biennium budget. This change will reduce our number of incoming students by one-third annually. In addition, we will not receive an ARCS recruitment fellowship during the 2009-2010 academic year due to a reduction in the overall number of fellowships the University of Washington will receive from the ARCS Foundation. We may be considered for this award for the 2010-2011 year.

II.C. RESOURCES

QERM is located on the third floor of Loew Hall, close to the center of campus. The first-year QERM students, who have their offices in Loew, have easy access to their statistics, forestry, and applied mathematics professors. They are also close to the Engineering, Mathematics Research, and Natural Sciences Libraries. They are a bit farther from the fisheries faculty, who are located on the Southwest Campus.

QERM's assigned space in Loew Hall includes:

- (1) 1 administrative office,
- (2) 6 student offices,
- (3) 1 library,
- (4) 1 conference room.

Joanne Besch, the Graduate Program Assistant, has her office in Loew 304. This is conveniently close to the Graduate Office of Admissions and the Graduate Office of Fellowships and Assistantships.

QERM students spend their first year in Loew Hall, where they develop a strong sense of camaraderie. Each first-year student has his or her own small, but private, office. At the end of their first year, most QERM students move into the labs of their advisors. We typically have one or two students whose advisors do not have student space. These students remain in Loew Hall beyond their first year.

The conference room is shared with other Graduate School and College of Engineering programs in Loew Hall, but nonetheless plays a crucial role in the program. It is the site of both faculty meetings and of the QERM weekly soup (lunch), which brings most of the graduate students in the program together on a regular basis. The library provides space for collaboration and contains a small collection of biology, mathematics, and statistics books.

Overall, our assigned space is appropriate for our current needs. QERM provides each student in Loew Hall with a computer and access to a laser printer. New computers are purchased with operating funds every third year (or so). The Graduate School has allowed us to carry unused operating-budget funds over from one year to the next in order to purchase new computers.

The J. W. Conquest Endowment Fund also supports QERM. This endowment has a balance of \$28,500 and was established by the Director, Loveday Conquest, in memory of her father. The program has used this endowment largely to pay for student travel to present at conferences. In late 2008, Prof. Conquest also established a separate QERM Endowment Fund, and Prof. James Anderson established a QERM Modeling Endowment Fund. These funds will be available on the QERM webpage for donations by alumni and friends of QERM.

II.D. STAFFING

Joanne Besch, the Graduate Program Assistant (GPA), is the sole QERM classified or professional staff member. As previously discussed in section II.A., the GPA manages administrative activities; serves as the primary contact and link between faculty, students, and administration; helps develop and implement program enhancements; and accesses a wide variety of campus services. Joanne Besch has been the QERM GPA since February, 1997 and has been at the University of Washington since 1983; Joanne's continued presence adds a tremendous amount of stability to the QERM program.

For several years Joanne was classified staff at the top of her pay scale. In March of 2004, Joanne was promoted to professional staff. This removed the lid on her salary and made her eligible for annual salary adjustments. The QERM GPA is a 50% FTE position. Joanne enjoys the flexibility that a half-time position provides; she has no desire to increase her hours QERM supports Joanne's continued professional development by paying for computing and administrative system training classes.

The academic staff is discussed in Section III.

SECTION III. FACULTY, TEACHING & DEGREE PROGRAMS

QERM brings together 30 faculty from 11 departments in 5 colleges or schools (see Appendix C). The diversity of the faculty, all of whom share an interest in quantitative ecology and resource management, is one of the main strengths of QERM. All of the QERM faculty currently have their primary appointments and salaries in the College of Arts and Sciences, the College of Forest Resources, the College of Ocean and Fishery Sciences, the School of Medicine, or the Daniel J. Evans School of Public Affairs. This has allowed QERM to build a critical mass of interested (and interesting) faculty at little cost. At the same time, faculty carry out their QERM duties on top of (and with no obvious release from) their usual departmental duties. The most important role of QERM faculty is, therefore, to mentor and supervise the QERM graduate students. We ask very little of QERM faculty in terms of classroom teaching (but see Section III.A.). Most QERM faculty participate in the program because of (a) their intrinsic interest in quantitative ecology and resource management and (b) the high quality of the QERM graduate students.

A challenge facing the QERM program is the aging of the QERM faculty (see Appendix I). Since the last self-study in 1996, the median age of the faculty, measured in years since Ph.D., has increased by 3 years. Many of the faculty who were instrumental in forming the program and who have been instrumental in running the program are approaching retirement. The faculty have taken several steps to deal with this transition:

1.) We have increased our recruiting in an effort to bring more young faculty into the program. New (core) recruits since the last self-study include:

- (a) Sandor Toth (Ph.D. 2005), College of Forest Resources

- (b) Steven Goodreau (Ph.D. 2001), Department of Anthropology
- (c) Tilmann Gneiting (Ph.D. 1997), Department of Statistics
- (d) Jennifer Ruesink (Ph.D. 1996) Department of Biology
- (e) John Horne (Ph.D. 1995) School of Aquatic and Fishery Sciences
- (f) Daniel Grunbaum (Ph.D. 1992) School of Oceanography
- (g) Susan Bolton (Ph.D. 1991) College of Forest Resources
- (h) Andre Punt (Ph.D.,1991) School of Aquatic and Fishery Sciences
- (i) Don Percival (Ph.D. 1983) Applied Physics Laboratory
- (jk) Joshua Lawler (Ph.D. 2000) College of Forest Resources
- (k) Ashley Steel (Ph.D. 1999) Northwest Fisheries Science Center (affiliate faculty, School of Aquatic & Fishery Sciences; can serve on, but not chair, QERM thesis committees).

New QERM faculty have been brought into the program by senior core faculty or, in several recent cases, by QERM graduate students who wished to work with new faculty. In all cases (Dr. Steel being the exception), the new faculty member must be nominated by a current faculty member, must already be a member of the graduate faculty, with an endorsement to chair a doctoral committee, and must be approved by a vote of the core QERM faculty.

2.) In 2006, the QERM faculty developed a systematic procedure for distinguishing core faculty, who are active in either oversight and administration of the program or in the supervision of graduate students, from affiliated faculty, who are less active in the program (see Appendix H). As senior faculty approach retirement, they often wind down their involvement with QERM. QERM's annual reassessment of faculty allows faculty to move gracefully from core to affiliated status. Affiliated faculty regain their core status if their level of activity surpasses a well-defined threshold.

The QERM program currently has 21 core faculty and 9 affiliated faculty. The median age of the affiliated faculty, measured in years since Ph.D., is 13 years higher than that of the core faculty (see also Appendix I).

The above steps have been quite helpful in maintaining the vitality of the program. Nevertheless, maintaining a diverse demographic is an important and long-term issue, especially with regard to the impact on core QERM courses and securing research funding to support QERM students.

III.A. TEACHING RESPONSIBILITIES

As previously mentioned, QERM faculty have their primary appointments in other departments. QERM therefore asks very little of its faculty in terms of classroom teaching. Nonetheless, there are several courses that are taught under the QERM banner. Currently, these include:

- (1) **QERM 514, Analysis of Ecological and Environmental Data I** (4 credits)
Loveday Conquest teaches this course. Professor Conquest provides an overview of generalized linear models (GLMs) and describes the use of GLMs in forestry, fisheries, wildlife ecology, and environmental monitoring. This course also attracts students from the two natural resource colleges, the Department of Biology, and other campus majors.

(2) *QERM 550, Ecological Modeling and Spatial Analysis* (5 credits)

This course is usually taught by David Ford. Professor Ford covers the principles of ecological modeling and the theoretical and methodological issues involved in the design and implementation of ecological models. He focuses on analyses of spatial processes and describes how these processes can be used to develop ecological models. (See Appendix L). This course also attracts students from the two natural resource colleges.

(3) *QERM 597, Seminar in Quantitative Ecology* (2 credits)

In the autumn, John R. Skalski leads a journal club in which the QERM first-year students, along with other students from the natural resource colleges, discuss classic papers and current topics in quantitative ecology. In spring, more advanced QERM students (and some faculty) present their research.

(4) *QERM 598, Special Topics in Quantitative Resource Management* (2 credits)

In recent years, this course has served as a short introduction to computational methods in ecological modeling for the first-year QERM graduate students. In particular, the students are taught the open-source statistical programming language R. The examples in this course have typically been drawn from other first-year courses. Both faculty and senior graduate students have taught this course. (Starting winter quarter 2009, first year students will learn the skills previously covered in QERM 598 by instead taking AMATH 410, Computational Biology and Chemistry. AMATH 410 will focus on deterministic and stochastic models arising in the biological and life sciences, using R for numerical computation and data analysis.)

All of the above courses play a key role in the first-year graduate curriculum (see Section III.D.1. and Appendix L).

In addition to classroom teaching, QERM faculty supervises QERM M.S. theses (QERM 700) and Ph.D. dissertations (QERM 800). Additional information regarding the mentoring of graduate students is available in Section III.C.2.

III.B. INSTRUCTIONAL EFFECTIVENESS

Appendix M contains a summary of the students' rating of QERM classroom instruction for 2002–2007. The Office of Educational Assessment provided these data. (Appendix D is less useful as it provides ratings for all UW interdisciplinary programs taken as a whole.) Courses were typically ranked from good to excellent. Since QERM has no faculty lines, matters of faculty promotion, merit pay, or tenure are decided upon in professors' home departments. QERM does, however, solicit and monitor student feedback and evaluations to make sure that core courses are taught well. QERM graduate students are also encouraged to teach, both as part of their formal training and as a means of support. In recent years, several QERM graduate students have worked as teaching assistants (TAs) and/or have taught their own classes. (In a typical year, 10-15% of the QERM students earn their support in this way.)

QERM TAs typically receive TA training in the department or program in which the TA position lives. Many QERM graduate students have, for example, worked for the Center for Quantitative Science (CQS). There is a symbiotic relationship with the Center for Quantitative Science (CQS)

where TAs are usually available for QERM students. Most of the CQS faculty (director Vincent F. Gallucci) are QERM members. Thus, QERM students have a good opportunity to obtain teaching experience. (See <http://depts.washington.edu/cqs/qerm.html> for details.) CQS sends the names of all their TAs to the Center for Instructional Development and Research (CIDR). CIDR, in turn, invites these students to attend CIDR's annual TA training conference (details at <http://depts.washington.edu/cidrweb/>). CQS TAs are also invited to attend the fall TA orientation and training offered by the School of Aquatic and Fishery Sciences (SAFS).

QERM occasionally asks senior graduate students with extensive teaching experience to teach QERM courses, on an as-needed basis. Student-taught QERM courses are always taught under the auspices of a QERM faculty member. In 2008, Eli Gurarie taught QERM 598 under the supervision of Dr. Tilmann Gneiting, and Hans Nesse taught QERM 514 under the supervision of Dr. Vince Gallucci.

In keeping with the requirements of Graduate School Memorandum Number 15 (<http://www.grad.washington.edu/acad/gsmemos/gsmemo15.htm>), any QERM international students must (1) meet English language proficiency requirements, (2) meet spoken English proficiency, and (3) participate fully in the International Teaching Assistant Program at the Center for Instructional Development and Research (CIDR) before undertaking any teaching duties

III.C. TEACHING & MENTORING OUTSIDE THE CLASSROOM: RECRUITMENT & MENTORING

The success of the QERM program depends on our ability to attract qualified graduate students and to then advise and mentor these same students. In this subsection, we summarize (a) recruitment patterns over the last decade and (b) the methods we use to advise and mentor students.

III.C.1. Recruitment

By all obvious measures (see Appendix J), the quantity and quality of applicants and recruits has stayed relatively constant over the last decade. QERM receives an average of 18 applications per year. The median GRE verbal and quantitative scores of applicants are 570 and 750; the median grade point average is 3.6. The high quantitative scores are in keeping with the quantitative nature of the program. Applicants typically have backgrounds in biology, environmental sciences, mathematics, natural resources, and/or statistics. Undergraduate degrees are from a wide variety of institutions. QERM applicants appear to be a self-selecting group of students. Most QERM applicants are either mathematics and statistics graduates looking to apply their skills to the study and management of natural resources, or ecology and natural resource graduates who want to enlarge their quantitative skill set. In almost all cases, applicants are attracted by the interdisciplinary nature of the program. Advertising (guides, flyers) does not appear to have much effect on the number of applicants. Rather, students find QERM on the web (e.g., search on "quantitative ecology graduate programs" or just "quantitative ecology") and apply because of the unique nature of the program. They are also attracted by the fact that they do not have to go immediately into a particular professor's research group; they have a little time (the first year) to attend seminars, talk with faculty and other students, and explore.

QERM recruits from 2 to 6 (the median is 3) new graduate students each year. The number of recruits is often limited by the number of support slots. The median GRE verbal and quantitative scores of the recruits are 615 and 775; the median grade point average is 3.65. QERM has been fortunate in that it participates in the science graduate recruitment program, Achievement Rewards for College Scientists (ARCS), which provides a cash award (see Appendix B) to a top entering student each year for three years. For QERM, the availability of the ARCS award has made it easier to recruit the very top students who are often being pursued by other programs at multiple universities.

Effective fall of 2009, the guaranteed number of funded slots for new students will be reduced from 3 to 2 due to cutbacks resulting from a decreased state budget.

III.C.2. Advising and Mentoring

QERM has a number of mechanisms in place to guarantee that students are properly advised. After admission, each new student is assigned an initial faculty advisor. The initial advisor, the Graduate Program Coordinator, and the Graduate Program Assistant all answer questions about courses, the program, and the university.

Each first-year student must choose a chair for his or her master's degree supervisory committee by the end of his (or her) third quarter of study. The chair helps the student select elective coursework, design a research project, and assemble the rest of the thesis committee. The master's degree supervisory committee oversees the student's course of study, research, master's thesis, and master's defense. Information regarding the master's degree supervisory committee is provided in Appendix O.

A student who enters the Ph.D. program must choose a chair for his or her doctoral supervisory committee by the end of the third quarter in the doctoral program. The chair is the major advisor for the student and helps the student assemble the rest of the supervisory committee. The supervisory committee advises the student and oversees the student's course of study, doctoral research, general exam, doctoral dissertation, and Ph.D. defense. Information regarding the doctoral supervisor committee is provided in Appendix S.

All students are required to submit an Annual Progress Report (see Appendix K). After reviewing the progress reports, the Graduate Program Coordinator (GPC) meets individually with each student. The purpose of this meeting is to gauge and discuss the student's progress and to advise the student regarding academic milestones, their roles and responsibilities as TAs or RAs, and so on. The GPC documents the meeting, sends a copy of the report to the student's advisor, and places a copy of the report in the student's permanent file. Students who are not making satisfactory progress are invited to discuss their work with the GPC and the student's supervisory-committee chair.

Another source of valuable mentoring occurs in the spring session of QERM 597. All QERM students in residence are required to register for this seminar each spring and all advanced students (students past their first year) are asked to present their research during this seminar. Students are asked to assess the strengths and weaknesses of their own talks. The graduate

students and faculty then critique the talks in attendance. The members of the audience provide constructive suggestions that help students improve their talks and their research plans, mathematical models, and data analyses.

In addition to getting advice and information about the program from meetings with faculty and staff, students obtain information from a number of other sources. Some of these other sources are official while other sources are informal. These sources include:

(1) <http://depts.washington.edu/qerm/>

This is the QERM web page. This site is kept as up-to-date as possible.

(2) http://depts.washington.edu/qerm/degrees/student_guide_2008_09.pdf

This is the URL for the QERM Student Handbook. This handbook is encyclopedic and was recently revised.

(3) <http://depts.washington.edu/cidrweb/RAWorkshop>

This webpage describes the annual training workshop for UW Graduate Research Assistants. Such a workshop occurs too soon for first-year QERM students, but is appropriate for second-year students.

(3) http://wiki.cbr.washington.edu/qerm/index.php/Main_Page

This is the URL for QERMipedia, a QERM graduate-student wiki. QERMipedia is an informal, rapidly evolving source of program information and announcements.

(4) QERM Soup

The graduate students take turns cooking soup for a weekly gathering of the members of the program. Since the advanced QERM students have their offices scattered around campus, the soup serves to bring students in the program together to exchange news and information. The QERM Director and the Graduate Program Assistant are regulars at soup.

III.D. DEGREE PROGRAMS

The QERM program provides students a unique opportunity to apply mathematics and statistics to a broad range of problems in terrestrial and marine ecology, natural resource management, biometrics, and mathematical biology. The program offers two graduate degrees, a Master of Science (M.S.), and a Doctor of Philosophy (Ph.D.). The M.S. requires a thesis and is expected to take two to three years (see Appendix P). The Ph.D. requires a dissertation and is intended to take four to five years (see Appendix T). Both degree programs rely on a common first-year sequence of core courses (see below and Appendix L).

III.D.1. Coursework

QERM requires a series of first-year core courses that cover the fundamentals of ecological modeling and statistical inference. Currently, the required courses are:

AMATH 422 Introduction to Mathematical Biology

AMATH 410	Computational Biology and Chemistry
QERM 514	Analysis of Ecological and Environmental Data
QERM 550	Ecological Modeling and Spatial Analysis
QERM 597	Journal Club (autumn); Seminar in Quantitative Ecology (spring)
QERM 600	Independent Study Credits, or seminar outside QERM
STAT512	Statistical Inference Theory I
STAT513	Statistical Inference Theory II

A detailed description of these courses is contained in Appendix L. All graduate students (in residence) are required to register for the QERM Seminar (QERM 597) in the spring. They are also required to register for one seminar each year in an affiliated department (e.g., Applied Math, Biology, Biostatistics, Fisheries, Forestry, Statistics).

In general, full-time graduate students register for 10 to 18 credits each quarter, with no more than 10 to 12 credits per quarter in graded courses. Students are expected to take courses in their area of emphasis (biometrics, mathematical modeling, or resource management) and to take biology or ecology courses that give background and insight into appropriate environmental systems. These courses are selected with the guidance of the student's supervisory committee (see Appendices O and S). A Plan of Study form documenting the required electives must be approved by the supervisory committee and kept in the student's permanent academic file.

M.S. students working on a thesis register for a minimum of 9 thesis credits (QERM 700); Ph.D. students working on a dissertation register for a minimum of 27 dissertation credits (QERM 800). Detailed course-credit requirements are spelled out in Appendix N (for the M.S.) and Appendix R (for the Ph.D.).

III.D.2. Qualifying Exams

At the end of their first year of study, all students are required (but see the next paragraph) to take the first-year statistical theory exam (administered jointly by Statistics, Biostatistics, and QERM) and the first-year applied methods examination (administered by QERM). The statistical theory exam is a three-hour exam with 4–7 questions on topics from basic probability theory, multivariable models, sampling results and asymptotic theory, estimation, testing and confidence intervals, and Bayesian methods. The applied methods exam is a 5–day take-home exam in which students are asked to demonstrate their ability to use and synthesize the material that they have learned in AMATH 422, QERM 514, and QERM 550 (ecological modeling, applied statistics, and spatial models). Computing is always required for this exam.

Occasionally, an entering student will have little or no statistics background. In that instance, prior to entering the program, the student is advised to take STAT 394-395 (Probability I and II), and possibly STAT 341–342 (Intro Prob Stat Inference I and II) or STAT 481 (Intro to Mathematical Statistics) to prepare in this area. The student is then prepared to take STAT 512–513 (Statistical Inference Theory I and II) during the first year of study in QERM.

Students entering the program with a master's degree in statistics are not required to take STAT 512–513 (Statistical Inference Theory I and II) if they already have the necessary background.

However, they must take a screening examination in September offered by the Department of Biostatistics to determine their competence. This “challenge” examination does not count as one of the two attempts to pass the statistical theory exam. Moreover, these students are still required to take the statistical theory exam after their first year of study. In general, students are advised to take STAT 512–513 in the year they take the statistical theory qualifying examination, and AMATH 422 (Introduction to Mathematical Biology), QERM 514 (Analysis of Ecological and Environmental Data), and QERM 550 (Applied Ecological Modeling) in the year they take the applied methods qualifying examination.

Master’s students must pass both the applied and statistical theory exams at the master’s level to remain in the QERM program. *Failure to pass either examination after a second attempt will result in the student’s graduate enrollment being terminated.* Each retaken exam must be retaken in its entirety.

For students to continue into a doctoral program, both the applied methods and statistical theory exams must be passed at the doctoral level. A student receiving a master’s pass may be reexamined one additional time to achieve a doctoral pass. If a doctoral pass is not achieved after the second attempt, *the student may not proceed into the doctoral degree program.* The student may, however, complete their M.S. degree in QERM.

Appendix V includes the success rate on the qualifying exams for each recent entering class. Most, but not all, students eventually pass the qualifying exams at the Ph.D. level.

III.D.3. Degree Programs

III.D.3.1. Master of Science

The QERM master’s degree is an integrated program of coursework and research during which students (a) master the fundamentals of statistical inference and ecological modeling, (b) gain additional expertise in an area of emphasis (biometry, mathematical modeling, or resource management), (c) learn relevant biology and ecology, and (d) learn how to conduct scholarly research. The QERM M.S. requires a thesis and is expected to take two to three years. Detailed requirements for the QERM master’s degree are listed in Appendix N.

A timeline for the QERM master’s degree appears in Appendix P. In their first year, QERM M.S. students take required classes (see Section III.D.1. and Appendix L), take their qualifying exams (see Section III.D.2.), identify their research advisor and second-year funding source. In their second year, these students form and convene their supervisory committees (see Appendix O), prepare their thesis proposals, and make progress on their M.S. theses. Theses are defended at a final exam.

Students admitted at the pre-master’s level may, under exceptional circumstances, proceed directly to post-master’s study after completing the QERM qualifying exams at the Ph.D. level. Please see Appendix Q for the procedures for a QERM master’s degree bypass.

QERM has awarded 38 M.S. degrees since 1991 and 30 M.S. degrees since the last self-study in

1996. The titles of theses are listed in Appendix U. Twenty-five (of 38) students left QERM after earning their M.S. Five students left to pursue doctorates in other fields; many graduates now work for the government or the private sector. Seven M.S. recipients went on to earn a Ph.D. from QERM; six M.S. recipients are currently pursuing their QERM doctorates. An abbreviated curricula vitae for a number of our M.S. and Ph.D. graduates can be found in Appendix W.

III.D.3.2 Doctor of Philosophy

The QERM doctoral degree is, first and foremost, a research degree. The granting of the degree is based on proficiency in statistical inference, ecological modeling, and resource management and upon a superior ability to carry out important and independent research, as demonstrated by the successful completion of a doctoral dissertation. Detailed requirements for the QERM Ph.D. degree are listed in Appendix R. These requirements include course requirements, passing Ph.D. qualifying and general exams, and the successful completion and defense of a dissertation. A general timeline for the QERM doctoral degree appears in Appendix T. A student's rate of progress does, however, depend upon his or her background. A student who has completed the QERM master's degree will usually have completed the first-year core courses and the qualifying exams and will thus be in a good position to make rapid progress towards the Ph.D. A student who has earned a (relevant) master's degree (with thesis) elsewhere usually needs to take the first-year core courses, but can then move into the Ph.D. program after passing his or her preliminary exams at the Ph.D. level. New students without relevant thesis experience are asked to complete a QERM M.S. before pursuing a QERM Ph.D. These students can skip their master's degrees only under exceptional circumstances: they need to pass their qualifying exams at the doctoral level and complete the master's bypass requirements (see Appendix Q).

As with most Ph.D. programs, each student's progress towards the Ph.D. is overseen by the student's dissertation advisor and doctoral supervisory committee (see Appendix S). A QERM doctoral supervisory committee consists of four or more faculty. At least three members of a student's doctoral supervisory committee must be members of the graduate faculty and at least two members must be members of the QERM faculty. The QERM faculty is quite diverse and most of the QERM faculty serves on a large number of student committees (see Appendix C).

QERM has awarded 29 Ph.D. degrees since 1991 and 23 Ph.D. degrees since the last self-study in 1996. The titles of QERM Ph.D. dissertations are listed in Appendix U. QERM is different from most academic departments in that a majority of QERM Ph.D. graduates pursue careers in government (where many desirable jobs are). Of QERM's 29 doctoral graduates, 19 currently work for the government, 5 hold academic positions, and 5 work in the private sector.

Government agencies or divisions with QERM doctoral graduates include:

- Food and Agriculture Organization (FAO) of the United Nations,
- Alberta Research Council, Canada
- Bureau of Land Management (BLM), U.S. Department of the Interior,
- National Marine Fisheries Service, NOAA,
- Pacific Wildland Fire Sciences Laboratory, USDA Forest Service
- United States Fish and Wildlife Service,

- Washington Department of Fish and Wildlife,
- Columbia River Inter-Tribal Fish Commission, and
- Utility Systems Management, City of Seattle.

Departments and universities with QERM doctoral graduates on their faculty include:

- School of Resource and Environmental Management, Simon Fraser University, Canada,
- Departamento de Probabilidad y Estadística, Instituto de Investigaciones en Matemáticas Aplicadas y en Sistemas, Universidad Nacional Autónoma de México, México.
- Department of Natural Resources, University of New Hampshire,

QERM graduates also work for private companies such environmental science firms, Boeing, health care research organizations and as private consultants. Curricula vitae for a number of our doctoral graduates can be found in Appendix W.

III.D.4. Educational Effectiveness

Due to the small size of the QERM program, the OAP Summary Data provide little information that we do not already know, including numbers on QERM courses, graduate student applications, admissions, enrollment, degrees awarded, and diversity. Student satisfaction is largely assessed through such venues as the Annual Progress Reports, meetings between students and the director, staying in touch through the weekly QERM Soup meetings, and the program assistant continually tracking each student's progress.

The effectiveness of the QERM program is largely measured by the success of our graduates. Students with a QERM M.S. are well poised to enter either a Ph.D. program, or the world of work. Ph.D. graduates, in addition to pursuing a traditional academic career, also have employment opportunities with private companies or government agencies. The vitae in Appendix W reveal that QERM graduates have won teaching awards (Aumann, Silverman), been a finalist for a national dissertation award (Aumann), and won Best Student Paper awards (Anderson, Buchanan, Steele-Feldman). Based in part upon his QERM research, R. Towell was the 2006 NOAA Fisheries Employee of the year, a national award. A. Steel received a 2006 Outstanding Federal Employee (Seattle) award, based in part upon research accomplishments. R. Sharma, a current Ph.D. student employed by the Columbia River Inter-Tribal Fish Commission (CRITFC), co-chairs a scientific committee of the Pacific Salmon Commission, which sets regulations for Pacific salmon fisheries. QERM students and QERM graduates are making their mark in the world of ecosystems and resource management. Aside from traditional faculty appointments, they hold leadership positions in government agencies or private firms.

The UW, particularly the two natural resource colleges and the Department of Biology, also benefits by having QERM students in with their departmental research group, and attending departmental seminars and social activities. "Qermies" can bring quantitative approaches to research discussions and often become the "go-to" persons when other students require help with a variety of quantitative problems.

Due to QERM's unique blend of mathematical and biological sciences, there are few, if any,

comparable graduate degree programs. For those students aiming primarily for careers as statistical scientists, QERM competes with statistics programs associated with forestry, fisheries, and wildlife, such as Oregon State University, Colorado State University, and N. Carolina State University. Colorado State Univ. has a Program for Interdisciplinary Mathematics, Ecology and Statistics (PRIMES), but a student must first enter a Ph.D. “home department” in order to participate in PRIMES. For those students anticipating careers as ecological modelers, QERM competes with programs in ecology or evolutionary biology, such as those at Princeton, the University of Michigan at Ann Arbor, and the University of California at Davis. Many of our applicants have told us that QERM was their first choice, sometimes their only choice. Our strong entering GRE scores, strong employment rates, and successful Ph.D. program acceptance rates for M.S. graduates are all indicators of the rigor and strength of QERM.

III.D.5. Improving the Quality and Productivity of QERM

QERM has made several changes to improve the quality and productivity of its program since the last review. These are listed below.

- a. The first-year coursework has been modified to achieve a more balanced workload during the year. We continue to review the first-year courses to ensure balance among the modeling, statistical, and decision sciences aspects of the program.
- b. We tightened up the admissions process by requiring all “finalists” for admission to visit QERM for a 2-day interview (international students are interviewed by telephone); this has resulted in a better fit of students to the program.
- c. We instituted a formal annual review process for each QERM student, and now assign each entering student an academic adviser.
- d. The QERM website has been completely redone and is updated as needed. A QERM handbook has been written and is also available online.
- e. We have recruited more young faculty into the QERM program, adding 12 new (core) recruits since the last self-study.
- f. The new designation of core faculty and affiliated faculty gives structure to reflect varying levels of participation of faculty in the QERM program.
- g. Following demolition of the Center for Quantitative Sciences building in 1997 (former home of QERM) and a few years in windowless offices in Bagley Hall, QERM has settled into its present space in Loew Hall. We now have a decent commons room, a QERM library, and small offices for first-year and some advanced students.

All this has helped improve the QERM program, which has evolved over time and is clearly not expected to remain static (see Section VII).

SECTION IV. DIVERSITY

QERM is committed to recruiting and retaining faculty and graduate students from underrepresented groups. A quarter of the core faculty, including the Program Director, are women and approximately half of the graduate students enrolled in the program since 1996 have been women (see Appendices D and X). We have had some success in recruiting Hispanic and Latino/a graduate students, have had one Native American tribal member. Among the faculty, Professor Conquest, the Program Director, is the most prominent minority member; she is of Pacific Islander/Asian descent. Appendix Y contains QERM's Diversity Plan, drafted in January 2006, for maintaining student, faculty, and staff diversity.

In addition to any and all activities listed in that plan, QERM:

- a. participates in the National Name and Western Name Exchange Consortia;
- b. applies for Graduate Opportunities & Minority Achievement Program (GO-MAP) RA funding when minority students are identified;
- c. participates in GO-MAP recruitment events;
- d. participates in the Graduate Diversity Recruiter Program.

The National Name Exchange Program and the Western Name Exchange Program are consortia of approximately 51 universities that collect and exchange names of talented underrepresented ethnic minority students who are in their junior or senior year of their undergraduate education. The purpose of the name exchanges is to ensure that participating universities continue to identify a pool of qualified students who can be recruited to the graduate programs at these "name-exchanging" institutions. The consortia also conduct other activities consistent with national efforts to increase the enrollment of traditionally underrepresented peoples in graduate education. GO-MAP has maintained access to the database for both exchanges since the mid-1980s.

Useful GO-MAP recruitment events include Recruitment Fridays and Prospective Student Days. Recruitment Fridays are GO-MAP's effort to accommodate departments and programs, such as QERM, whose on-campus admissions visits occur prior to spring quarter. Recruitment Fridays provide prospective minority students an opportunity to meet Associate Dean Juan Guerra, the GO-MAP staff, graduate diversity recruiters, and faculty and current graduate students of color. Prospective Student Days, in contrast, occur spring quarter. On those days, GO-MAP hosts a reception, a campus tour, and an information lunch and provides recruits an opportunity to network with students and faculty from other departments and to learn about funding, housing, campus, and Seattle. Minority students who have been admitted by QERM are invited to participate in Prospective Student Days.

QERM also takes advantage of the Graduate Diversity Recruiter (GDR) program. This program introduces prospective graduate students to the rich cultural diversity at UW and in the Seattle area. GO-MAP has a trained corps of current graduate students who can, for example, lead tours of campus emphasizing diversity resources and points of interest relevant to a specific academic program.

SECTION V. RESEARCH AND CREATIVITY

In a nutshell, QERM faculty, with their students, work to develop rigorous quantitative models motivated by problems in ecology, environmental sciences, and natural resource management. Areas where QERM faculty have advanced the field include the following: fisheries management and stock assessment, forestry and forest ecology, methods for wildlife assessment and climate science, models of the dynamics of biological populations, and network models, to name a few. Highlighted below are research accomplishments of QERM faculty (for more details see Appendix E), particularly those who have involved research undertaken with QERM students. Over the past decade, developments in the power of computing and the availability of free software such as “R” (now heavily used in the life sciences) allow for the use of computer-intensive techniques (e.g., simulations, nonlinear estimation) to carry out investigations not possible before. QERM faculty have also published software in conjunction with sophisticated models.

Fisheries/Wildlife Management and Stock Assessment. QERM faculty have been key players in several major developments in fishery sciences. For example, the Columbia Basin Research Program (CBR), which addresses salmon issues in the Columbia River basin, was spearheaded by two QERM faculty, James Anderson and John Skalski. Their group has developed complex salmon passage models to evaluate impacts of the Columbia River hydrosystem on migrating salmon, along with webpages featuring both historical and real-time data. Their models and their data are used continually by agencies to develop multi-objective strategies for fisheries management.

Dr. Skalski has designed hydroacoustic sampling programs for hydro projects involving major dams on the Snake and Columbia rivers. His fish-tagging and radiotelemetry studies involving mark-recapture models have allowed scientists to incorporate a variety of predictors on assessing run-timing of Columbia River juvenile and adult salmon, in addition to other types of wildlife populations. Other research includes assessing impacts of larval fish entrainment at coastal nuclear power plants, and incorporating smolt survival rates for “fish-friendly” turbines. Dr. Skalski is also well known for his work on developing demographic models for wildlife populations and game management.

Andre Punt and Ray Hilborn are two major international players in the field of fisheries and marine mammal stock assessment and management. QERM students working with Drs. Hilborn and Punt are developing methods for improving the scientific basis for fisheries management decision making in collaboration with research scientists from the Northwest and Alaska Fisheries Science Centers. The results of this research are regularly presented to the scientific committees of the two west coast Fishery Management Councils, and the method developed by Punt to evaluate rebuilding strategies for overfished fish stocks forms a key basis for the rebuilding plans for the stocks. Punt’s research on using Bayesian hierarchical modeling and spatial models for whale and other marine mammal abundance has also led him to serve on the Scientific Committee of the International Whaling Commission. In that respect, he has continued the work of QERM faculty Judith Zeh, whose research on stock assessment, age estimation, and population studies on bowhead whales also led to her chairing the International Whaling Commission Scientific Committee.

Ray Hilborn has developed algorithms and software for fisheries stock assessment and fisheries management systems in the U.S. (Alaska and West Coast groundfisheries), Canada, South America and New Zealand. His research also includes quantitative models for fishers' decision-making behavior and fishing fleet dynamics. He also investigates the role of hatcheries in Pacific salmon management, and has developed statistical methods used in testing dynamic ecological hypotheses. In 2006, Hilborn was awarded Sweden's prestigious Volvo Environmental Prize.

In other areas of fishery science, Vince Gallucci is well known for his work on conservation and management and population dynamics on sharks, particularly Puget Sound and Alaska dogfish (about which populations relatively little is known). He has also developed fisheries management models for artisanal fisheries in developing countries. He frequently is *amicus curie* (guest of court) on shark fisheries on both the Atlantic and Pacific coasts when industry sues the Federal government in Federal court. The use of hydroacoustic techniques to aquatic ecology and resource management has been advanced through the work of John Horne. His work includes comparing predictions from morphologically-based acoustic models to laboratory and field measurements, acoustic identification of fish species, and spatio-temporal patchiness of distributions of aquatic organisms. Jennifer Ruesink works on models for invasions by aquatic organisms. She was recruited to QERM to work with a student on the spread of green crab and its settlement patterns on the west coast of N. America. Loveday Conquest has worked in studies of endangered seabirds, particularly as they interact with commercial fisheries, and ecological sampling models that involve human judgment in the sampling process, both research areas having involved QERM students..

Forestry/Forest Ecology. David Ford has forged major developments in foliage canopy dynamics, including foliage regeneration and morphology, for plants as different as maize and old growth forests. He also broke ground on characterizing uncertainty in ecological models using an economic concept known as Pareto optimality. This work is being applied to forest landscape planning using a parallel computer and is being taken up by the Forest Service Fire Ecology Laboratory attached to CFR. Ford's work also includes analysis of spatial pattern in ecology and relationships of wildlife with habitat.

Following a number of retirements, CFR has, over the last 18 months, appointed a number of new faculty with strong interests in quantitative approaches, in particular Josh Lawlor (landscape ecology, conservation biology), Monica Moskal (remote sensing, biospatial analysis, now serving on a QERM student's thesis committee) and Sandor Toth (natural resource informatics). Dr. Toth, a new QERM member who will teach a QERM core course beginning Spring 2010 (see Appendix L), develops quantitative decision support tools in the areas of forest and natural resource management. He is particularly interested in mathematical models to quantify and visualize resource trade-offs and production possibilities between conflicting management objectives. This includes forest planning using multiple criteria, and the economics of non-timber forest benefits.

Atmospheric Sciences/Climate. Peter Guttorp is best known for his research on spatial statistics, particularly as it relates to air pollution, atmospheric processes, and climate change. Tilmann Gneiting works on statistics and meteorology, including probabilistic forecasting and weather

forecasting using ensemble methods. The website www.probcast.washington.edu provides real-time weather information to the general public. Don Percival is best known for his work on spectral (time series) analysis and wavelets, with applications to atmospheric data, sea ice thickness, and coastal sea level fluctuations.

Applied Mathematics/Ecology. Mark Kot works at the interface of applied mathematics, ecology, and evolutionary biology. Recently his research has centered on integrodifference equations, a class of spatial models that are discrete in time and continuous in space, for the growth and spread of biological populations. These equations, extremely useful for modeling biological invasions, are more flexible and more realistic than simple reaction-diffusion models. A second theme has been the nonlinear dynamics of (even simple) ecological models, with emphasis on bifurcations and complex and chaotic dynamics.

Network Models. A recent member of QERM is Steven Goodreau, a biocultural anthropologist who focuses on the transmission and evolution of infectious diseases, such as HIV, within complex networks of human social interactions. Dr. Goodreau joined QERM in order to work with a QERM student wishing to do both theoretical and applied work in network models.

The availability of QERM students to tackle “thorny”, mathematically complex problems in a variety of areas can greatly enhance a faculty member’s productivity. Armed with mathematical and computing expertise, QERM students allow faculty to pursue certain types of problems that they might otherwise not be able to undertake. However, there are things that might prevent a faculty member who wishes to participate in QERM from doing so. Barriers could arise in the form of departmental chairs discouraging their faculty from supervising students outside that faculty member’s home department (although QERM has been lucky in this respect, presumably due to our excellent reputation). For those faculty who teach QERM core courses, if chairs demand production of many student credit hours from their faculty (this seems to become an issue whenever budget cuts are faced, like the present), this can be problematic for that faculty member and for the QERM program.

With regard to junior faculty, while QERM has no faculty lines, QERM senior faculty are always on the lookout for new faculty hires who might benefit from membership in QERM and who could contribute to the QERM program. These can be faculty from the two resource colleges (Forest Resources/Ocean & Fishery Sciences) or elsewhere (e.g. Anthropology) who seek highly qualified quantitative students to tackle research problems, or faculty from departments like Statistics and Applied Mathematics seeking quantitative students with interests and backgrounds in biology and ecology to work on certain types of applied problems. Certainly no faculty member is ever required to join QERM; the only faculty who are in QERM are those who wish to be.

To reduce barriers between QERM and its associated departments, and to balance productivity expectations of QERM with home departments, QERM maintains communication with departments to let them know what the program is about, and how the presence of QERM students in a faculty member’s research group can enhance the productivity in that group. We have been successful with this so far; nevertheless it is a constant balancing act. Our success is helped by QERM students “becoming” part of a faculty member’s home department by actively

participating in and contributing to a professor's research group, seminars, and social activities in that department.

SECTION VI. COLLABORATIONS & INTERDISCIPLINARITY

By its very nature, QERM must collaborate with other units at the UW. Since QERM has no faculty lines, its participating faculty are drawn from various departments. Currently the core faculty are predominantly from Statistics, Applied Math, College of Forest Resources, and the College of Ocean & Fishery Sciences. Faculty from different departments collaborate in a variety of ways. One occurs in discussions of the core of the QERM program (e.g., what courses, what fields of study), or in discussions of the material for the QERM qualifying exam. QERM faculty must continually view the world through the prism of disciplines not their own. The other occurs by having faculty from different departments on a student's M.S. or Ph.D. committee. For example, a QERM Ph.D. committee could have four faculty members from four different departments (even four different colleges!). In order to effectively guide a QERM student's research, faculty must engage in "interdisciplinary conversation". QERM faculty realize the complicated nature of environmental and ecological problems and are thus committed to working collaboratively with scientists from fields not their own.

An example of collaborative success is that QERM played a vital role in the landing of a five-year grant that funded a multidisciplinary research center for environmental statistics in the late 1990's and early 2000's from the U.S. Environmental Protection Agency. At the time of the grant award, EPA reviewers stated that a key component was the true collaboration among Statistics, Biostatistics, QERM, and the two natural resource colleges, CFR and SAFS.

QERM thrives by maintaining good relationships with a number of units across campus. QERM depends upon core QERM faculty (who come from a variety of departments) to teach QERM courses. Other classes in the QERM first-year core are taught both by QERM and non-QERM faculty. After the first year, all QERM students are funded through sources (RAships and TAships) outside of QERM. Thus, it is imperative that faculty from the participating departments view QERM students as desirable and worthy of funding. For example, the School of Aquatic & Fishery Sciences (SAFS) awards fellowship quarters (funded by endowments) to QERM students pursuing fisheries-related research. This reflects the esteem in which SAFS holds the QERM program. The fact that departments allow QERM students to have precious departmental graduate office space is another indicator of the "research value" of QERM students to their various advisors. QERM students also participate in their adopted "home department's" seminars and social gatherings. In terms of graduate student recruitment, the ability to interact with faculty from a variety of departments in tackling an ecological or environmental research problem is often mentioned by student applicants as drawing them to QERM.

QERM demands a certain amount of work from its participating faculty members, particularly those who teach courses that form the QERM first year core. Faculty who support QERM students via RA or TA departmental funds must justify allocating such funds to a student who is technically outside the department. The only "academic reward" that QERM has to offer is—top students to join a professor's research group! The fact that QERM students are continually sought for this very purpose is a tribute to the success of the QERM program.

SECTION VII. FUTURE DIRECTIONS

The QERM program is reviewed by faculty on an annual basis. For example, because so many of the first-year courses are taught through departments, it is necessary for QERM to continually review the availability of the courses, their content, and their relevance to the QERM program. As senior QERM faculty retire, the program must ensure that there are enough participating faculty in a variety of departments to be available to QERM students and to chair their thesis committees. And, as departments take on new quantitative faculty, some of them will have interests that could lead them to becoming members of QERM. For example, right now QERM has a lot of participation from faculty in the School of Aquatic and Fishery Sciences (SAFS), which built its research reputation in part on having a strong quantitative component. QERM could benefit from more participation by faculty in the College of Forest Resources (CFR), which for many years did not hire new faculty but which has brought on new quantitative hires in the last three years. One of them (Toth) has joined the QERM program and will be teaching part of the first-year core in Spring 2010 (ESRM 590, see Appendix L). Prof. Josh Lawler also joined and is serving on a QERM student's thesis committee. Others are being "courted" by QERM in the hope that they will become QERM members.

There are at least three potential opportunities for QERM in the next few years (see Appendix F, Strategic Plan). One is the potential launching of the QERM certificate. Graduate certificate programs enable government employees, private-sector employees, graduate non-matriculated students, and matriculated graduate students (in other fields) to develop graduate expertise without enrolling in a master's or doctoral program. Certificate programs are increasingly attractive options for working professionals and busy graduate students. A fee-based certificate program, in addition to enhancing quantitative skills of working scientific professionals, could also be a source of additional funds for the QERM program.

QERM is considering developing a graduate certificate in quantitative ecology and resource management. We would expect this certificate to attract (a) scientists in nearby government agencies; (b) graduate students in quantitative departments, such as statistics and biostatistics, who wish to round out their education with exposure to ecological modeling and decision sciences; and (c) graduate students in applied fields, such as fisheries and forestry, who wish to increase their quantitative training. In terms of the formal vetting process, the University of Washington's policies regarding graduate certificate programs are outlined in Graduate School Memorandum No. 43 and in the Graduate School Guidelines for Graduate Certificate Programs (see Appendix Z). A certificate program must be a linked series of credit-bearing graduate courses forming a coherent body of study. (A graduate certificate program requires at least fifteen student credit hours, nine of which must be earned in courses numbered 500 and above.) In addition, the certificate program must culminate in a capstone experience, such as a project or a comprehensive exam, that adds intellectual cohesion to the program and that draws on the entire content of the program.

The QERM Master of Science and Doctor of Philosophy degrees are research degrees that culminate in a thesis or a dissertation. Both degree programs rely on a common first-year sequence of core courses. We believe that this first-year sequence of courses could form the basis for a certificate program and that the QERM Applied Exam would be an appropriate

capstone experience. If the QERM certificate were to be approved by the QERM faculty and the Graduate School during 2009-2010, QERM could begin taking applicants starting in Fall 2010.

A second possible opportunity for QERM is UW's new College of the Environment (CoEnv). The very name of QERM -- "Quantitative Ecology and Resource Management" -- seems to some almost a "no-brainer" in terms of being part of the new CoEnv. However, there has been much spirited discussion among UW faculty in general regarding the make-up and governance of the new CoEnv. Some UW units joined almost immediately; others have held back. The current state of the economy and state budget cutbacks also complicate the picture for the CoEnv. QERM has fared reasonably well being housed in the Graduate School, even though we are will experience fellowship cuts as part of the current (bleak) state budget picture. QERM faculty will need to engage in thoughtful discussion regarding QERM's role with the new CoEnv. QERM could easily serve as a nexus for research and teaching activity in quantitative ecology in the new environmental college, something we have always desired.

The third issue concerns faculty demographics. Professors Conquest (QERM Director), Anderson, Ford, and Gallucci are all over 60 years of age. Presumably there will be retirements among these (and possibly other QERM faculty) within the next 5-10 years. Thus, the need will arise to choose a new QERM Director. QERM 514, Analysis of Ecological and Environmental Data (one of Conquest's signature courses), will need a new instructor, or else the QERM core will need reconfiguring so that the first-year students obtain this knowledge in a different manner. Prof. Ford's course, QERM 550, Ecological Modeling and Spatial Analysis, is being replaced by (new QERM member) Prof. Sandor Toth's course, ESRM 590, Quantitative Decisions in Natural Resources, beginning in Spring 2010. (*Note: this is not due to impending retirement for Prof. Ford, but rather because he is required by his college to produce more student credit hours.*) Profs. Anderson and Gallucci, while having no specific QERM courses as a signature course, nevertheless are key participating member of QERM in terms of long-term planning, admissions, and the annual qualifying exams. They also advise and fund QERM students on a regular basis, so QERM will have to ensure that its students can still look to other faculty in the School of Aquatic & Fishery Sciences for interesting research projects and associated support.

QERM's fundamental needs include the one-year (9 month) fellowships for the entering students. These are absolutely essential, as QERM students spend their entire first year learning fundamental underpinnings in mathematical and applied statistics, spatial statistics, ecological modeling, and computer programming. They compete in classes with M.S. and Ph.D. students in Statistics, Biostatistics, and Applied Mathematics, in addition to students from Biology and the natural resource colleges. It would not serve the first-year students well to be spending time on a traditional, 20-hours-per-week, project-directed research assistantship while trying to study for the first-year qualifying exams. Beginning in Fall 2009, the usual three QERM fellowships from the Graduate School will shrink to two. We will receive an additional fellowship through the Hall-Ammerer Endowment in fall 2009, but this is by no means guaranteed beyond 2009. If there are entering QERM students who are clearly fisheries-oriented, it may be possible to obtain first-year funding from endowment fellowships through the School of Aquatic & Fishery Sciences—again, by no means guaranteed. Having only two students enter each fall would likely shrink the size of QERM to below critical mass, so this is a serious issue. QERM gets enough

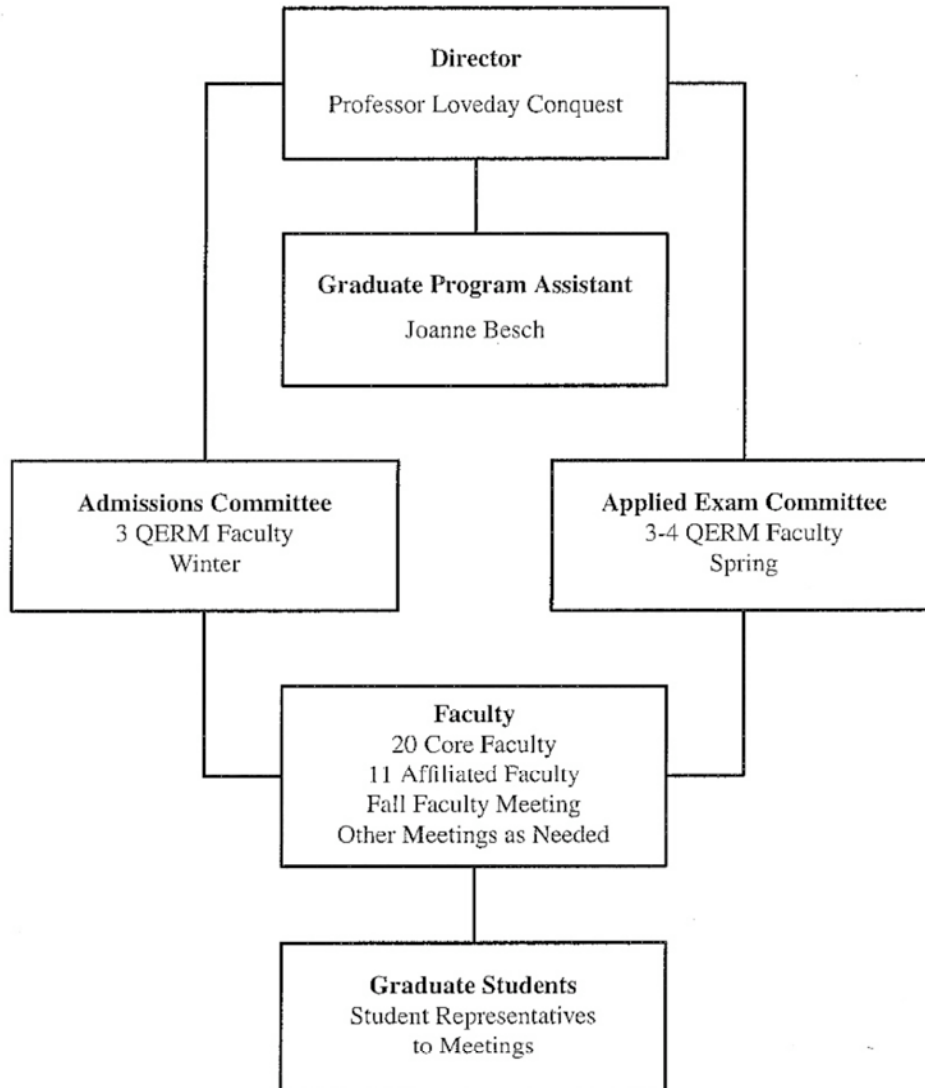
applicants so that it could take as many as five or six new students each year, if we had sufficient funding and office space for them. Students who enter with funding through agency agreements (e.g., the National Marine Fisheries Service) provide a way to enhance recruitment; however this represents a limited set of potential students. Having more first-year fellowships would have a significant impact in that it would allow the QERM program to sustain about five to eight more students that it currently does.

The critical “glue” that holds the QERM program together consists of a certain amount of student and staff funding, and space for QERM activities. The issue of student funding has been addressed above. Other essentials include space for all the first-year and some of the advanced QERM students, a “commons” area for the weekly QERM soup and for problem-working sessions to study together and prepare for the qualifying exams, and a small library. If a QERM certificate program materializes, the administrative demands could grow. It is crucial to minimize the administrative workload on the QERM faculty; otherwise participation in QERM could become too much of a burden and not worth the rewards of working with QERM students. Therefore, the part-time Program Assistant to oversee the needs of the QERM students and faculty is essential.

REQUIRED APPENDICES

**APPENDIX A
ORGANIZATION**

**Appendix A
Organization Chart
Governance and Planning**



APPENDIX B
BUDGET SUMMARY

ANNUAL BUDGET FROM GRADUATE SCHOOL (EFFECTIVE 2009-2011 BIENNIUM*)

\$56,098	Salaries Graduate Program Assistant (50% FTE) (\$25,500 annually) Program Director (\$4,500 9-mo. administrative stipend) Two 9-month graduate students appointments (\$13,049 each) with tuition waiver.
\$ 6,000	Operating Costs Includes: telephones, postage, photocopying, computer equipment and software (for both staff and students), staff training, teaching materials, office supplies, textbooks (for library), travel
\$ 1,000	Discretionary Funds Includes: recruitment lunches, food for QERM meetings and events
<u>\$63,098</u>	<u>TOTAL SUPPLEMENTAL BUDGET</u>

SUPPLEMENTAL REQUESTS – GRADUATE SCHOOL

\$15,000	9-month WRF Hall-Ammerer Fellowship (\$15,000 stipend with tuition waiver)
\$ 5,833	ARCS Recruitment Fellowship (3 year award) (Year 1: \$7,500; Years 2 & 3: \$5,000 each)
\$ 1,500	GSFEI Recruitment Travel Award (\$1,500)
\$ 600	GSFEI Graduate Student Travel Funds (amount varies due to number of requests and availability of funds)
<u>\$22,333</u>	<u>TOTAL SUPPLEMENTAL BUDGET</u>

Each year, we apply for the above supplemental funding. Over the last several years, we have received this funding, but there are no guarantees that these funds will be available in the future. We recently learned that we will not receive the ARCS Fellowship in 2009/2010 due to a reduction in the overall number of fellowships awarded to the University of Washington by the ARCS Foundation.

In addition, graduate students frequently apply for Travel Awards to present talks at national and/or international meetings. Graduate Student Travel Awards are \$300 for local travel and \$500 for international travel. Funding is limited and is provided on a first-come, first-served basis.

** Prior to the 2009-2011 biennium the Graduate School funded three 9-month graduate student assistantships with tuition waiver. This number will be reduced to two starting with the 2009-2011 biennium due to state budget cuts*

APPENDIX C
QERM FACULTY

QERM CORE FACULTY

James Anderson, Research Professor, School of Aquatic and Fishery Sciences

Url: <http://www.cbr.washington.edu/%7ejim/>

QERM Committees:	M.S. Since 1991	M.S. 2007- 2008	Ph.D. Since 1991	Ph.D. 2007-2008
Chair	4	1	4	1
Co-Chair	1	0	2	0
Member	2	0	0	0

Susan Bolton, Professor, College of Forest Resources

Url: <http://www.cfr.washington.edu/People/faculty.asp?ID=145>

QERM Committees:	M.S. Since 1991	M.S. 2007- 2008	Ph.D. Since 1991	Ph.D. 2007-2008
Chair	1	1	0	0
Co-Chair	0	0	0	0
Member	0	0	1	0

Loveday Conquest, Professor, School of Aquatic and Fishery Sciences

Url: <http://fish.washington.edu/people/conquest/>

QERM Committees:	M.S. Since 1991	M.S. 2007- 2008	Ph.D. Since 1991	Ph.D. 2007-2008
Chair	4	0	1	0
Co-Chair	1	0	0	0
Member	8	1	2	0

E. David Ford, Professor, College of Forest Resources

Url: <http://faculty.washington.edu/edford/>

QERM Committees:	M.S. Since 1991	M.S. 2007- 2008	Ph.D. Since 1991	Ph.D. 2007-2008
Chair	7	0	6	2
Co-Chair	0	0	0	0
Member	0	0	1	0

Vincent F.Gallucci, Professor, School of Aquatic and Fishery Sciences
Url: <http://fish.washington.edu/people/gallucci/>

QERM Committees:	M.S. Since 1991	M.S. 2007- 2008	Ph.D. Since 1991	Ph.D. 2007-2008
Chair	4	2	2	1
Co-Chair	0	0	0	0
Member	2	1	2	0

Tilmann Gneiting, Professor, Department of Statistics
Url: <http://www.stat.washington.edu/tilmann/>

QERM Committees:	M.S. Since 1991	M.S. 2007- 2008	Ph.D. Since 1991	Ph.D. 2007-2008
Chair	0	0	0	0
Co-Chair	0	0	0	0
Member	0	0	2	1

Steve Goodreau, Assistant Professor, Department of Anthropology
Url: <http://faculty.washington.edu/goodreau/>

QERM Committees:	M.S. Since 1991	M.S. 2007- 2008	Ph.D. Since 1991	Ph.D. 2007-2008
Chair	1	1	0	0
Co-Chair	0	0	0	0
Member	0	0	0	0

Daniel Grunbaum, Associate Professor, School of Oceanography
Url: <http://faculty.washington.edu/random/>

QERM Committees:	M.S. Since 1991	M.S. 2007- 2008	Ph.D. Since 1991	Ph.D. 2007-2008
Chair	0	0	0	0
Co-Chair	0	0	0	0
Member	0	0	1	1

Peter Guttorp, Professor, Department of Statistics
Url: <http://www.stat.washington.edu/peter/>

QERM Committees:	M.S. Since 1991	M.S. 2007- 2008	Ph.D. Since 1991	Ph.D. 2007-2008
Chair	0	0	0	0
Co-Chair	0	0	2	0
Member	4	0	6	1

Ray Hilborn, Professor, School of Aquatic and Fishery Sciences
Url: <http://www.fish.washington.edu/people/rayh/>

QERM Committees:	M.S. Since 1991	M.S. 2007- 2008	Ph.D. Since 1991	Ph.D. 2007-2008
Chair	4	1	2	0
Co-Chair	0	0	1	0
Member	1	0	5	2

John Horne, Research Associate Professor, School of Aquatic and Fishery Sciences
Url: <http://www.acoustics.washington.edu/hornefac/>

QERM Committees:	M.S. Since 1991	M.S. 2007- 2008	Ph.D. Since 1991	Ph.D. 2007-2008
Chair	1	1	0	0
Co-Chair	0	0	0	0
Member	1	1	0	0

Mark Kot, Associate Professor, Department of Applied Mathematics
Url: <http://www.amath.washington.edu/~kot/>

QERM Committees:	M.S. Since 1991	M.S. 2007- 2008	Ph.D. Since 1991	Ph.D. 2007-2008
Chair	0	0	1	0
Co-Chair	0	0	0	0
Member	1	1	5	2

Joshua Lawler, Assistant Professor, College of Forest Resources
Url: <http://www.cfr.washington.edu/CFRPublic/People/FacultyProfile.aspx?PID=54>

QERM Committees:	M.S. Since 1991	M.S. 2007- 2008	Ph.D. Since 1991	Ph.D. 2007-2008
Chair	0	0	0	0
Co-Chair	0	0	0	0
Member	0	1	0	0

Don Percival, Principal Mathematician, Applied Physics Laboratory
Url: <http://faculty.washington.edu/dbp/>

QERM Committees:	M.S. Since 1991	M.S. 2007- 2008	Ph.D. Since 1991	Ph.D. 2007-2008
Chair	0	0	1	1
Co-Chair	0	0	0	0
Member	1	0	0	0

Andre Punt, Professor, School of Aquatic and Fishery Sciences
Url: <http://www.fish.washington.edu/people/punt/>

QERM Committees:	M.S. Since 1991	M.S. 2007- 2008	Ph.D. Since 1991	Ph.D. 2007-2008
Chair	2	1	1	1
Co-Chair	0	0	0	0
Member	3	3	2	1

Jennifer Ruesink, Associate Professor, Department of Biology
Url: <http://depts.washington.edu/jrlrlab/>

QERM Committees:	M.S. Since 1991	M.S. 2007- 2008	Ph.D. Since 1991	Ph.D. 2007-2008
Chair	1	1	0	0
Co-Chair	0	0	0	0
Member	0	0	0	0

John Skalski, Professor, School of Aquatic and Fishery Sciences
Url: <http://fish.washington.edu/people/skalski/>

QERM Committees:	M.S. Since 1991	M.S. 2007- 2008	Ph.D. Since 1991	Ph.D. 2007-2008
Chair	6	2	7	0
Co-Chair	0	0	0	0
Member	2	0	1	0

* **E. Ashley Steel**, Affil. Assist. Prof., Aquatic and Fishery Sciences, NW Fisheries Science Center (*can serve on committees, not endorsed to chair on a committee*)
Url: http://www.nwfsc.noaa.gov/research/staff/display_staffprofile.cfm?staffid=702

QERM Committees:	M.S. Since 1991	M.S. 2007- 2008	Ph.D. Since 1991	Ph.D. 2007-2008
Chair	0	0	0	0
Co-Chair	0	0	0	0
Member	2	1	0	0

Sandor Toth, Assistant Professor, College of Forest Resources
Url: <http://faculty.washington.edu/toths/>

QERM Committees:	M.S. Since 1991	M.S. 2007- 2008	Ph.D. Since 1991	Ph.D. 2007-2008
Chair	0	0	0	0
Co-Chair	0	0	0	0
Member	0	0	0	0