INSTRUCTIONS
QERM Applied Qualifying Exam
Spring Quarter 2003 (June 19 – June 24, 2003)

This packet should contain:

1. This cover sheet.
2. Examination (in two parts).
3. Hard copy of datasets for Question 1 and Question 2. Joanne Besch will also e-mail both datasets to you. Please check and make sure that you receive these datasets and contact her ASAP if you have difficulty receiving the datasets.

INSTRUCTIONS:

1. Provide a 1-2 page summary at the very beginning of your examination.

2. Clearly describe in your text the points that diagrams and tables demonstrate.

3. All graphs should be labeled clearly and computer output annotated as need be.

4. Appendix pages should be numbered so that any referring to the Appendix refers to a particular set of pages.

5. Paginate your exam.

6. Each student is issued a unique identification number, located at the top of this instruction sheet. That identification number must be **clearly** marked on **EVERY** page of the examination. **DO NOT INCLUDE YOUR NAME** on the examination.

7. If you make anything in color please provide 5 color copies. If using only black print, 1 copy is sufficient.

8. Completed examinations must be returned to the QERM office (Loew 304) by 10:00 a.m. on Tuesday, June 24th.

LIBRARY HOURS:

** *REMEMBER*** the library is **CLOSED** Saturday and Sunday, June 21-22, so any reference materials you might need should be checked out before then.

QUESTIONS?

Dr. Conquest should be contacted if there are questions on the statistical portion of the exam. Her office phone is 221-7966, home phone number 206-325-7237. She will be leaving town on Sunday but can be reached by e-mail at conquest@u.washington.edu or by phone at 808-732-1573.

Questions regarding the modeling portion of the exam may be directed to David Ford at edford@u.washington.edu, Office phone: 685-9995, home phone: 206-324-9174.

Joanne will be out of the office after 11:30 on Thursday, June 19th and will be in the office from 9:30 to 11:00 on Friday, June 20th. She will be in the office on Monday and Tuesday from 9:30 a.m. to 2:30 p.m. Feel free to e-mail her at jbesch@u.washington.edu, or call her at home, 525-2414.

Good luck!

QERM QUALIFYING EXAMINATION 2003

Blackberry plants (*Rubus* species) have been introduced into Australia from Eurasia and are frequently considered as an invasive exotic species that competes vigorously with native vegetation. This problem exists in many parts of the world. Control is difficult. Mechanical methods that do not dig up the roots are not successful unless applied repeatedly. Biological control using a fungus has been tried, but blackberry seems quite resistant. The most frequently used method is herbicide application.

Blackberry plants produce vines that arise from a central crown or from buds that form along rhizomes (horizontal, underground shoots). The major cause of blackberries spreading is by cane tip-rooting. First year canes (primocanes) grow rapidly, have few leaves and do not bear flowers or fruit. In the autumn, the tops of the canes that are touching the ground can take root and form daughter plants. Second year canes (floricanes) have more leaves and produce flowers and fruit and are frequently considered to be best for translocating herbicides back to the mother root system. After their second year the canes frequently die although canes in their third year do exist and their lateral branches extend adding to the dense leaf cover often found in blackberry patches. Blackberry plants can live for 25 years or more; but within a dense patch the life of the individual crown is shorter, usually 2 to 3 years, because there is frequently competition-driven mortality causing individual crowns cease to produce new shoots.

To control blackberries with herbicide, the chemical must be transported within the plant to the rhizomes and new growing points. For this to occur, the herbicide must move in the phloem with the plant sugars produced through photosynthesis. In early summer during the rapid extension of canes and expansion of foliar tissue, sugars are transported within the plant from the underground storage tissues to the shoots. After midsummer, new growth is reduced in wild blackberry first-year canes (non-flowering shoots) because these shoots are actively transporting sugars to the rhizomes. In the flowering shoots (second-year canes), movement of sugars from the shoots to the rhizomes occurs later in the season than it does for first-year canes and is most active after completion of fruiting.

Obtaining good control of blackberry using a foliar herbicide requires application that coincides with the maximum rate of sugar movement to the root system. This will depend upon whether the plants are primarily first-year canes or a combination of both first- and second-year canes. Where the bramble infestation consists of a combination of first- and second-year canes, it is generally thought that herbicide should be applied in mid-summer. Herbicides applied too early generally result in good kill of the top growth, but very little movement of the chemical to the root system. Consequently, the plant re-grows. It is important to note that plants under stress from drought or grazing do not translocate sugars as rapidly as do actively growing plants. Thus, chemical control of wild blackberry plants under stress is difficult.

QUESTION 1, PART A.

The positions of 1st, 2nd and 3rd year canes at ground level in a 3m X 3m plot of a blackberry patch were carefully mapped in two successive years in early summer after the new shoots (called 1st year) had sprouted. Determine the spatial structure of the patch and how it develops from one year to the next. Write a model for this development. You may wish to use the *make.pattern* function in your exploratory analysis of this data but the model that you present should be written in S-plus (or C) code and should be fully annotated and the purpose of its different components should be clearly described. Describe how you estimate parameters for the model.

QUESTION 1, PART B.

In mid-summer of the second year, the herbicide Picloram was applied at a rate of 6 kg/ha to this mapped plot. At the end of the growing season, the plot was re-mapped. Analyze the data and describe what you think happened as a result of the herbicide application.

QUESTION 2

The attached data set concerns the effect of time of spraying on the control of blackberry by either a single or a repeated application of herbicides. The three herbicides used were: 2,4,5-T, Picloram, and Activated Aminotriazole (AA). "Treatment" is a combination of dose (not sprayed, half-rate, full-rate) and time of application (January or April and sometimes both). Response is cane density, number of live canes per m^2. Results are given for two species, *R. procerus* and R. *ulmifolius* hybrid.

Obtain your best statistical model (that relates cane density to the various predictors) for these data. In summarizing the details of your chosen model, answer the following questions:

QUESTION 2, PART A.

Which herbicides seem to do better than others (in terms of keeping blackberry cane density as low as possible), and at which dosages and times of application?

QUESTION 2, PART B.

Also discuss any difference in results for the two species.

Data for Question # 1 (parts A+B)

Spatial Distribution of Canes at Year 1

Age	x	y	(in meters)
1	2.26	0.04	
1	0.30	0.66	
1	0.81	0.50	
1	2.82	0.45	
1	1.29	1.79	
1	2.28	2.09	
1	0.29	2.72	
1	2.96	1.56	
1	0.00	1.86	
1	1.19	0.76	
1	2.00	1.78	
1	0.41	1.46	
1	0.95	2.51	
1	2.76	1.07	
1	0.23	0.26	
1	1.33	1.19	
1	2.97	2.36	
1	2.90	0.06	
1	1.82	2.98	
1	2.83	2.93	
1	1.69	0.95	
1	0.87	2.89	
1	1.44	0.09	
1	0.87	1.37	
1	2.65	1.95	
1	0.03	1.01	
1	0.97	0.11	
1	0.02	2.40	
2	1.83	1.31	
2	2.25	1.28	
2	0.75	1.93	
2	1.65	0.48	
2	1.56	2.20	
2	2.04	0.61	
2	2.23	0.02	
2	0.34	0.65	
2	0.78	0.45	
2	2.83	0.40	
2	1.24	1.77	
2	2.20	2.11	
2	0.90	2.43	
2	2.70	1.04	
2	0.31	0.22	
2	1.40	1.16	
2	2.99	2.30	
2	2.95	0.11	
2	1.78	2.99	

Data for Question 4 (parts A+B)

2	2.83	2.94
2	1.65	0.88
2	0.83	2.82
2	1.38	0.13
2	0.87	1.32
2	2.64	1.90
2	0.00	0.96
2	0.94	0.13
2	0.04	2.46
3	1.74	1.30
3	2.15	1.23
3	0.80	1.82
3	1.72	0.48
3	1.60	2.18
3	2.09	0.63
3	2.33	2.73
3	1.29	2.54
3	0.46	1.00
3	0.47	0.03
3	0.46	2.30
3	2.49	1.39
3	0.92	2.42
3	2.75	1.09
3	0.28	0.18
3	1.28	1.19
3	2.98	2.32
3	2.95	0.13
3	1.79	2.99
3	2.82	2.94
3	1.69	0.95
3	0.93	2.87
3	1.45	0.10
3	0.94	1.34
3	2.66	1.95
3	0.06	1.06
3	1.02	0.08
3	0.10	2.42

Spatial Distribution of Canes at Year 2

Age	x	y (in meters)
1	2.19	2.57
1	0.69	0.95
1	0.42	2.10
1	2.33	2.98
1	1.31	2.98
1	2.53	1.53
1	2.28	0.11

Data for Questie #1
(parts A+B)

1	0.40	0.64
1	0.79	0.53
1	2.87	0.51
1	1.20	1.74
1	2.27	2.17
1	0.37	2.74
1	2.93	1.61
1	0.07	1.84
1	1.18	0.72
1	1.96	1.87
1	0.49	1.41
1	0.90	2.51
1	2.77	0.99
1	0.27	0.22
1	1.36	1.13
1	3.03	2.38
1	3.00	0.01
1	1.88	3.08
1	2.77	2.93
1	1.60	0.95
1	0.82	2.80
2	2.26	0.04
2	0.30	0.66
2	0.81	0.50
2	2.82	0.45
2	1.29	1.79
2	2.28	2.09
2	0.29	2.72
2	2.96	1.56
2	0.00	1.86
2	1.19	0.76
2	2.00	1.78
2	0.41	1.46
2	0.95	2.51
2	2.76	1.07
2	0.23	0.26
2	1.33	1.19
2	2.97	2.36
2	2.90	0.06
2	1.82	2.98
2	2.83	2.93
2	1.69	0.95
2	0.87	2.89
2	1.44	0.09
2	0.87	1.37
2	2.65	1.95
2	0.03	1.01
2	0.97	0.11
2	0.02	2.40
3	1.83	1.31
3	2.25	1.28

3	0.75	1.93
3	1.65	0.48
3	1.56	2.20
3	2.04	0.61
3	2.23	0.02
3	0.34	0.65
3	0.78	0.45
3	2.83	0.40
3	1.24	1.77
3	2.20	2.11
3	0.90	2.43
3	2.70	1.04
3	0.31	0.22
3	1.40	1.16
3	2.99	2.30
3	2.95	0.11
3	1.78	2.99
3	2.83	2.94
3	1.65	0.88
3	0.83	2.82
3	1.38	0.13
3	0.87	1.32
3	2.64	1.90
3	0.00	0.96
3	0.94	0.13
3	0.04	2.46

Spatial Distribution of Canes at Year 2 after Picloram application

Age	x	y	(in meters)
1	2.53	1.53	
1	2.28	0.11	
1	0.79	0.53	
1	2.27	2.17	
1	0.37	2.74	
1	2.93	1.61	
1	0.49	1.41	
1	3.03	2.38	
1	1.60	0.95	
2	1.29	1.79	
2	2.28	2.09	
2	2.96	1.56	
2	1.19	0.76	
2	0.95	2.51	
2	1.33	1.19	
2	2.97	2.36	
2	2.90	0.06	
2	1.82	2.98	
2	0.87	2.89	

Data for Question #1
(parts A+B)

2	0.87	1.37
3	1.83	1.31
3	2.25	1.28
3	1.65	0.48
3	1.56	2.20
3	2.04	0.61
3	0.34	0.65
3	0.78	0.45
3	2.83	0.40
3	1.24	1.77
3	2.20	2.11
3	0.90	2.43
3	2.70	1.04
3	2.95	0.11
3	1.38	0.13
3	0.87	1.32
3	2.64	1.90
3	0.00	0.96
3	0.94	0.13
3	0.04	2.46

EXPLANATION OF VARIABLES FOR QUESTION 2

RowNames is the case number.

"ncanes" is the number of canes/m^2.

"species". 1 = R. procerus; 2 = R. ulmifolius.

"herbicide". 1 = 2,4,5-T; 2 = Picloram; 3 = Activated Aminotriazole

"trtmnt".
1 = Full rate applied in January only and nothing in April;
2 = Nothing applied in January and full rate applied in April;
3 = Half-rate applied in January and half-rate applied in April;
4 = Full rate applied in January and half-rate applied in April;
5 = Half-rate applied in January and full rate applied in April;
6 = Full-rate applied in January and full rate applied in April.

Data for Question 2
page 1 of 4

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Data for Question 2
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Data for Question 2
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