February 9, 2001

FW 662 Midterm Exam

This exam is a take-home, open-book exercise. There are 4 questions; you must answer all of them, including multiple parts. You may use any reference material (class notes, assigned reading, library material, etc.). Under NO circumstances are you to discuss this exam with classmates or any other individual. You are to work independently and you should not confer with others. If you need clarification on a question, please see the instructor, or send email with your question to gwhite@cnr.colostate.edu . This exam is to be turned in by 8:00 am Monday, 12 February, at the start of class. Turn in this sheet with your written answers and a disk that holds the spreadsheet models on which your answers are based. All questions require a written answer. In addition, some questions also require you to provide a spreadsheet demonstrating how you obtained your answer. Typed, short, concise answers will be graded more generously than hand-written, long, rambling responses. Your **spreadsheets on a diskette for questions 1, 2, and 4** will be used to verify that your answers were obtained in a logical fashion, and provide you with partial credit in cases where you got the wrong solution, but just made a simple mistake in the spreadsheet. **Identify your answer sheets and disks with your SSN only.** Only put your name (via your signature) on this sheet.

By my signature below, I certify that I have not collaborated with anyone concerning any material related to this examination.

________________ ________________________________ ____________________

SSN Signature Date

1. The Mexican Spotted Owl (MSO) is a threatened species under the Endangered Species Act, with only limited demographic data available. Based on the existing natural history information, the average number of young fledged per pair is 1.5, and adult (birds at least 2-years old and older) survival rate is 0.88. For the purposes of this problem, assume that owls begin nesting on their second birthday, i.e., when they are 2-years old. Unfortunately, no useful data exist to estimate the juvenile survival rate.
   a. (20 pts) What would the product of the survival for juveniles (birds in the age category from fledging to their first birthday and subadults (birds in the age category from 1 year to 2 years old) have to be to make the population have λ=1?
   b. (5 pts) What additional information did you have to supply to make your estimate?

2. The Mexican Spotted Owl (MSO) is a threatened species under the Endangered Species Act. For delisting this species, the Mexican Spotted Owl Recovery Plan requires that the population be monitored for a 10-year period (i.e., 10 estimates of population size across 9 intervals) with a power of 90% to detect a decline in the population of 20%. Since the plan has been written, newly acquired data have been used to estimate the temporal process standard deviation of λ to be 0.113.
   a. (15 pts) Given this process standard deviation and assuming that the population is currently stable (i.e., $\bar{\lambda}$ = 1), what is your best guess at the probability of the MSO population declining 20% over the 10-year interval?
   b. (5 pts) What assumptions did you make to estimate this probability, and how might slightly different assumptions change your estimate?

3. You are the Regional Environmental Contaminants Coordinator for the US Fish and Wildlife Service at the Denver Regional Office. You are working on a fairly controversial issue regarding the evaluation of blackbird population control to protect sunflower crops in North and South Dakota. For several years, APHIS' National Wildlife Research Center has been evaluating the merits of controlling blackbird populations to protect sunflowers. The approach they are examining calls for lethal control using the avicide DRC-1339. Spring migrating blackbirds (red-winged, yellow-headed, and common grackles) congregate in large roosts in southeastern South Dakota. The general approach calls for killing up to 2 million red-winged blackbirds in the vicinity of these roosts in April. It is their belief that killing 2 million birds each year over a three-year study period will reduce breeding blackbirds in the Dakotas and southern Manitoba and Saskatchewan and in turn will reduce the damage that occurs to sunflowers in late August to mid-September. Population size of red-winged blackbirds is about 25 million.
   a. (10 pts) Frame this question in terms of red-winged blackbird population dynamics. What are the questions you would ask and want answers for to evaluate this proposal?
   b. (10 pts) What data on population dynamics would you require before you issued the permit?
4. The following (simulated) stock and recruitment data are provided for a sub-population of

the endangered Sacramento River chinook salmon population in California. The stock are fish spawning in the river in year *t*, and the recruits are mature fish that return in 4 years.

Stock	Recruits
200	382
250	590
300	1151
350	763
400	1110
450	1091
500	1220
550	845
600	1155
650	1929
700	1643
750	1449
800	1823
850	1733
900	1120
950	1151
1000	1664
1050	1016
1100	1339
1150	1440
1200	1626
1250	1605
1300	1744
1350	1841
1400	1595
1450	1248
1500	1312
1550	1645
1600	2107

A. (20 pts) Estimate the parameters for a Ricker stock-recruitment curve from these data, and graph your predicted recruitment curve and observed data against the stock values.

B. (15 pts) In recent years, the stock for this population has been hovering around 1500 fish. The Coleman National Fish Hatchery will begin stocking an additional 1,500,000 smolts each year to supplement the production of wild fish. Smolts are young salmon ready to leave the river, returning in 4 years or so as part of the recruits. Based on your results in part A, what is your evaluation of the usefulness of stocking these smolts? Will stocking be beneficial or detrimental to the numbers of recruits? What additional information would you like to have to make a full assessment of this issue?

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FW662 Midterm Exam Answers

1. A. The product of survival is 0.1600. See the Midterm01.xls spreadsheet for how the problem was set up. Something that many of you didn't understand is that you can set the subadult survival to 1 and just estimate with Solver the juvenile survival that makes λ = 1. This trick works because there is no reproduction by birds on their first birthday. Another way is to set the rates equal, and then find the value of the square root of the product. Note that if you used Solver to find both survival rates simultaneously, you will get one (correct) solution of the infinitely many possible. Several of you tried to set the problem up as only 2 age classes, but this doesn't work unless you embed a juvenile survival rate into the reproduction rate of N_{SA} birds.

   B. You had to assume that the sex ratio was 50:50, or at least assume a sex ratio. Lots of other assumptions could be stated, i.e., density independence, no demographic or process variations, no senescence, etc., but I was really wanting you to point out that the sex ratio had not been specified in the problem.

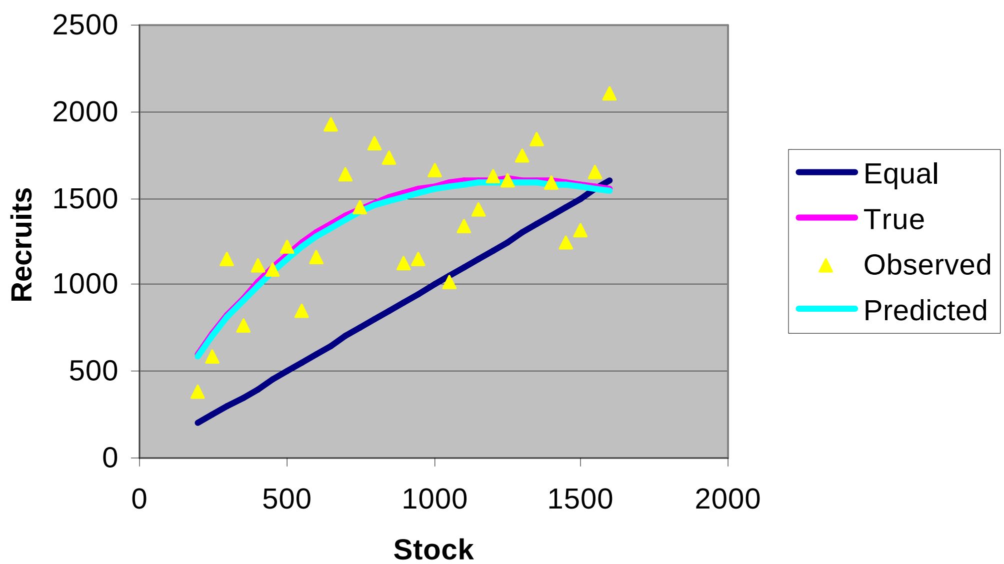
2. A. Again, see the spreadsheet for the appropriate way to program the solution. I started off the population with a value of λ = 1, and just multiplied by 9 NORMINV functions with a SD of 0.113 and $\bar{x}$ of 1. The correct answer is 31.3% (based on a million replicates). You could use any value for the starting population, and would still get the correct answer if you computed the percent decline correctly. Some of the common mistakes were to do 10 intervals (representing 11 years of data), something I didn't take off credit for. Other problems were not recognizing how to use the IF statement of Excel to return a 1 if the last value was a decline of >20%, or the COUNTIF function. Note that you are not interested in exactly a 20% decline, but a decline of at least 20%. Some of you recognized that the population could decline by 20% and yet not show an overall decline of 20% across the 9 intervals, something I hadn't thought about.

   B. The assumption I wanted you to mention is that you used the normal distribution to model λ. Some of you were cleaver enough to use the LOGINV function in Excel, a function that I wasn't aware of. You could also model λ as an exponential distribution with mean 1 and SD 0.113. In either case, the results are very sensitive to the assumption of what distribution you use. Other assumptions of no demographic or temporal variation were fine also, but in my mind, the key assumption is that λ has a symmetric distribution around 1. Some of you picked up on the fact that allowing λ to have a constant mean means that recovering from a low population might be slower than if density dependence were allowed to work.

2. A. Lots of questions you might ask, but the first one is why control in the spring if the damage is coming in the fall? This raises all kinds of questions about compensatory mortality and density-dependent reproduction.

   B. You would want some data to demonstrate that there is no compensation in the fall population for the loss of 2 million birds in the spring. In particular, is there density-dependent reproduction that would replace the 2 million birds by fall, or compensatory mortality (from density-dependent mortality) that would likewise replace the 2 million birds by fall. Other questions that are relevant are process variances, means, etc. But, without a curve that documents mortality and reproduction as a function of density, you really can't evaluate the impact of the control.

3. A. Correct estimates are $\hat{a}$ = 3.415469, $\hat{b}$ = 0.000789, $\hat{R}_0$ = 1.228315, and $\hat{K}$ = 1557.043. These estimates assume an error with the normal distribution. If you assume an error with the lognormal distribution, you get slightly different estimates, but still very close. I generated the data with normal error. Note how close the predicted line is to the true curve in the following figure. Note that $\ln(a) = R_0$, and $K = \ln(a)/b$.



B. The effect of the hatchery fish is complicated, and you don't have enough information to make a really intelligent decision. If you assume that the released fish act on wild fish with density dependence based on the curve fitted in part A, then the answer is clearly that the hatchery fish will wreck recruitment, lowering it to 0. However, this conclusion assumes that the density dependence in the population is coming from the releases while they are in the river, because it seems unlikely to me that this strong density dependence would be exerted while the fish are in the marine environment (although there may eventually be data to show that some density dependence is operating in the marine environment). If you believe that the hatchery fish go immediately to the ocean, and hence, the curve fitted in part A is irrelevant, then they would have no impact. The argument made by hatchery supporters is that the smolt released from the hatchery migrate immediately to the river, and do not impact the native fish. This is the research question in Ed Weber's dissertation.