Carleton UNIVERSITY
Canada's Capital University
Department of Biology

BIOL 3602
Conservation Biology

Fall Term 2012

Exam Question List

INSTRUCTIONS

Below is a list of nine exam questions divided into three groups A. Conservation Genetics; B. Biodiversity, and Threats to Biodiversity; and C. Species Conservation.

Two questions from each group will be on the exam. From each group you choose one question to answer.

For the 3 hr exam assume a writing time of 1 hour per question (1 hr * 3 questions = 3 hrs).

Make sure your answers are clear and concise. Marks are awarded for each new thought, that is, not for the same thought re-written in different ways. Provide background evidence/ examples to support your arguments. The more detail you write that is contextually relevant, the higher your mark. Assume decent grades (e.g., B+) can be obtained by *writing at a pace of one mark per minute* (e.g., each question ≈ 60 marks).

Suggestions:

- Do not waste time at the beginning of your answer by rewriting the question.
- Write specifically with purpose.
- If you can say the SAME thing in fewer words (without compromising good English) then do so.
- Consider that all questions can be approached from a 3-tier hierarchical perspective.
- Make sure you *address the question*, and do not write a beautiful essay on some tangent.

GROUP A. Conservation Genetics

1. A paper published in May 2005 proclaimed the ivory-billed woodpecker (*Campephilus principalis*) was no longer extinct (Fitzpatrick *et al*., 2005). Such a paper was surprising because the ivory-billed woodpecker had not been observed since 1944, and thus was thought to be long extinct. The 2005 paper reported evidence of at least a handful of individuals persisting in the Big Woods region of Arkansas. Bird lovers and conservationists have been celebrating the news ever since.

   However, the recovery of this species is uncertain. The bird remains elusive - in 2006 a $10 000 reward was offered for any information that would help researchers find an actual nest. In 2008 a $50 000 award was offered. Assuming the bird is present, and that the Endangered Species Act now protects the habitat where Fitzpatrick 2005's observations were made, why is the ivory-billed woodpecker's recovery uncertain? Address your answer within the context of *small populations* and *conservation genetics*.

2. The Puerto Rican Parrot (*Amazona vittata*) is one of the most endangered birds in the world. Once abundant and distributed across Puerto Rico, the species collapsed to a mere 200 individuals, all confined to the rainforest of the Luquillo Mountains of eastern Puerto Rico. Range contraction and concurrent population decline were associated with widespread deforestation in the late nineteenth and early twentieth centuries. At the peak of deforestation, only 10% of the island was covered by forest. The vulnerability of the Puerto Rican Parrot to forest loss is three-fold: it is dependent on fruit resources to feed; it relies on large-diameter trees for nesting cavities; and it suffers from heavy predation by Red-tailed Hawks when flying in the open. Although remaining forests are generally well protected, the Puerto Rican Parrots continued to decline to 14 individuals in the early 1970's. Current threats include competition for nest cavities by other bird species, and bees; introduced rats; and excessive humidity from recent hurricanes (wet cavities contribute to chick respiratory diseases). The future of the Puerto Rican Parrot indeed looks bleak.

   To help save the Puerto Rican Parrot a captive breeding program was initiated in 1993. With good intention these initial efforts however, failed. Not to be discouraged funding for a new captive breeding program has began. Within the budget is a position for a program manager – someone who knows the theory of captive breeding, and can identify the pitfalls if such a program is not strictly adhered to. Having you yourself applied for the job, you have now been invited to an interview.

   Demonstrate your preparation for the hour long interview by first outlining in the absence of a captive breeding program, what the genetic issues are for a small population. Then, outline the steps involved in a captive breeding program, and for each step demonstrate your detailed understanding of how/why each step is significant. In short, provide the theoretical underpinnings of a captive breeding program from the initial selection of individuals from the wild, to rebuilding populations and releasing individuals back into the wild. Explain where and why failures of the program might or could occur.

3. Define each of the following terms. For each term, detail its significance to Conservation Biology providing an example.

   a. Allele effect
   b. Allopatric populations
   c. Cryptic species
   d. Demographic stochasticity
   e. Effective population size
   f. Fixation index
   g. Founder effect
   h. Genetic bottleneck
   i. Genetic drift
   j. Heterozygosity
   k. Heterozygous advantage
   l. Inbreeding
   m. Inbreeding depression
   n. Mean Kinship
   o. Minimum viable population
   p. Nei's index of genetic distance
   q. Outbreeding depression
   r. Population Viability Analysis
   s. Studbook
   t. Sympatric populations

GROUP B. Biodiversity, & Threats to Biodiversity

4. During the late 1970's it was estimated that humanity had reached a 1:1 ratio between natural resource consumption, and natural resource regeneration. Today, we exceed this ratio by 40% meaning that we are consuming natural resources faster than they are able to regenerate (e.g., it takes the Earth one year and five months to regenerate what we use in one year). This most recent 2005 estimate is consistent with an extinction rate 1000 times the natural level, a potential runaway greenhouse effect, widespread degradation of forest and crop land, and collapsing fisheries world wide.

   The momentum of change is not in Earth's favour. On October 12, 1999 for example, the world population tipped the scales at 6 billion inhabitants. October 31, 2011 it was estimated to have passed 7 billion.

   As the year 2020 approaches human populations are expected to exceed 9 billion people. Such a population is considered maximum the currently available productive landscapes can provide for assuming (a) no food produce is lost or wasted, and (b) all humanity has equal access to the resources. Throw in a dose of reality in that one hectare of productive land is lost to deforestation, desertification, urbanization, or salt and toxic contamination every 7.67 seconds (=14.08 km^2 during your three hour exam) and the year 2020 may be upon us much sooner.

   To avoid increasing our ecological footprint any further than what it already is, identify 5 independent approaches that could help increase agriculture (and/or marine) productivity per unit area of land area without further compromising biodiversity. The mechanisms you identify must balance human needs with biological conservation. Thus cutting down forests to increase arable landscapes is not considered a viable option because of the loss to biodiversity this incurs. Consider mechanisms that differ on the biological/conservational scale from local to landscape. For each mechanism you identify detail the pros and cons so as to convince a skeptical audience as to their overall viability. Consider mechanisms, as examples, such as aquaculture, pest management, soil conservation, water treatment, marine protected areas, GMO's etc.

5. Various hunting groups promote themselves as conservation oriented by purchasing and saving wetlands across the North American landscape. It is true that without hunting influences many wetlands today would otherwise be agricultural land, marinas, suburban sprawl, hotels, or other. However, with all the lead pellets released from shotgun blasts and lead weights lost via anglers through fishing, these hunting groups' motto of conservation is somewhat superficial.

   In a similar vein, many industrial compounds of societal value are being identified as having endocrine disrupting capabilities. Such compounds include DDT, TBT, PCB and synthetic estrogens.

   As a further onslaught to the environment, lack of proper sewage treatment promotes eutrophication in the receiving water ways.

   Since lead, mercury and other metals naturally occur, phytoestrogens naturally occur in plants, and the sewage we release is no more than food we eat, why should we be concerned with the release of these naturally occurring substances back into the environment? Discuss how these substances contribute to biodiversity loss. Provide detailed pathways.

6. Barro Colorado Island was formerly a hilltop in a lowland forest landscape along the Chagres River on the Atlantic slope of central Panama. Between 1911 and 1914, thousands of hectares of lowland forest were flooded to create Gatun Lake and the Panama Canal, which isolated the 1600-ha hilltop from the surrounding mainland forest. In 1923 Barro Colorado Island was declared a biological reserve. Records of the avifauna (birds) were then kept by numerous visiting biologists and as such, probably no other tropical location has been so well studied. The nearly continuous presence of ornithological research on Barro Colorado Island provides an opportunity to evaluate the dynamics of species richness declines due to habitat fragmentation and isolation. Since the 1920's 65 of 394 bird species have disappeared from the island. (Fig. 3.1).

   Assuming hunting, egg poaching, nearby land clearing, and other human induced anthropogenic disturbances (outside of the original 1911-1914 flooding) are NOT relevant factors, what ecological processes could be responsible for the species decline? Identify minimally 5 mechanisms, order your list as to their likely temporal sequencing (i.e., which likely had an effect first, and then second, and son on), and then detail each mechanism clearly.

   Next, if you were provisioned with a 100 year opportunity to restore species diversity, what management strategies should you impose? Detail these strategies and clearly illustrate how each could help improve species diversity.

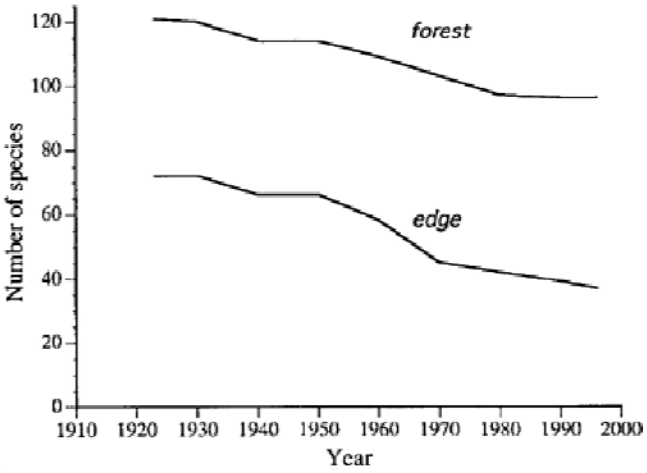

Figure 6.1. Loss of forest- and edge-dwelling resident avifauna species from Barro Colorado Island since its isolation in the early 20th century.

GROUP C. Species Conservation (budgets are not required)

7. As an expert on coral reef fisheries you have been invited by the Jamaican Government to a week long workshop in Discovery Bay, Jamaica. At issue is the *ratchet effect* of the declining coastal coral reef fishery. The *ratchet effect* suggests that the more effort people put into fishing, the fewer the fish are that remain. The Jamaican Government now plans to specifically address this problem – but alas, with its monitoring programs shut down for the past 19 years the government is at a loss of what to do. Your wisdom is keenly sought to help turn things around. Given that you have an hour for your presentation, provide your detailed thoughts equally on such areas as:

   - the concepts of reef overfishing in all of its guises and the consequences of such fishing practices.
   - other anthropogenic stresses stereotypical to coral reef systems that may just as much contribute to the fisheries problems of today.
   - proposed solutions to the problem – explain in detail how your proposed solution(s) could help restore the reef biodiversity and the Jamaican fishery.

8. A new sub-species of grizzly bear (*Ursus* sp.) has recently been discovered in the remote coastal mountain regions of northern British Columbia. Nothing is known about the ecology of the bear – except that (a) prior to winter hibernation the bear gorges on returning Pacific salmon swimming upriver to spawn, and (b) each major drainage basin appears to host its own bear population.

   Recognizing the uniqueness of the bear the federal government is considering a bear sanctuary (national park) where logging of the coastal temperate rainforests and hunting will be banned. The logging companies are naturally unhappy with this, and are thus soliciting for as small a park as possible. In response the Federal Gov is requesting proposals so as to determine what the ***minimal park size*** should be.

   Develop a research proposal whose goal is to determine the minimal park size to ensure bear survival for 1000 years. Restrict your proposal to 5 key research areas from genetic to landscape, that if combined will help establish the minimal park size. For each research area detail the ecological/conservational significance of why the issue needs to be addressed, and how you might go about resolving it. Known of grizzly bears:

   a) grizzly bears seldom live more than 25 years.
   b) female bears reach sexual maturity between the ages of 4 to 8 years old and breed at 3- to 4-year intervals (males mature between the ages of 5 to 10 years). A female bear may give birth to about eight cubs during her life.
   c) grizzly bears are solitary mammals needing territories between 200–600 km^2 (females) and 900–1800 km^2 (males).
   d) logging roads cutting through to otherwise isolated areas make grizzly bears a target for increased legal and illegal hunting.

e) grizzly bears are so sensitive to human incursion that they will often retreat from areas used for light recreation such as hiking.

f) there are already two north coast grizzly bear sanctuaries nearby: the Khutzeymateen Valley, 443 km^2 with its surrounding reserve area (total 3850 km^2) and the Kitlope Valley, 3887 km^2.

9. The rhinoceroses of Africa and Asia have a history similar to the elephant. Conversion of their natural woodland and grassland habitat for agriculture and development, along with hunting pressures for horns has taken a toll on all 5 species of rhinoceros. The southern white rhino (*Ceratotherium simum*), for example, came very close to extinction by the beginning of the 20th century. Although its range is now greatly reduced from its former distribution, recent protection of habitat and bans on hunting have permitted the population to increase from 30 individuals to 11300 today. Within the Hluhluwe-Umfolozi reserve (Fig. 9.1) in northeastern South Africa, the white rhino population is increasing at a rate of 9.5% per year (compare to the world human population growth rate of 1.4%). Today the white rhino population is at twice its carry capacity. The grasslands that the rhinos feed on occur naturally in the Hluhluwe-Umfolozi reserve, yet much of the grass is grazed to the ground and thus has little chance to grow back before being eaten again.

Figure 9.1. Hluhluwe-Umfolozi Game Reserve, located 280 km north of Durban, is the oldest proclaimed park in Africa. It consists of 960 km^2 of hilly topography in central Zululand, KwaZulu-Natal, South Africa.

As the nutrient reserves in the roots are used up, the grasses can not generate enough above ground biomass to photosynthesize and so the plant dies. As the surface of the ground defoliates (plants die), nothing is present to hold on to the rich organic material in the soil. In heavily grazed areas natural forces such as water and wind are eroding away the O- and A- soil horizons leaving behind sandy B-horizons of little nutrient value.

It is feared that if the rhinoceros population continues to increase or even remain at its present density, the ecosystem will be irreversibly desertified and will not be able to support rhinoceroses at all.

Design a multi-scale (from genetic to landscape) conservation strategy to save the Hluhluwe-Umfolozi rhinoceros population. Justify your strategy by providing detailed scientific arguments to support the plan's details. You may assume:

a) White rhinos live to approx. 50 years of age. They tend to group in territorial harems of one dominant male with several females. Females become sexually mature at 6 to 7 years (males 10 to 12 years), and reproduce 1 calf every 2 to 3 years thereafter totaling 5 to 6 calves.

b) The wide mouth of the white rhino is an adaptation to cropping large swaths of grass (as compared to the Black Rhino who has a narrow mouth adapted to eating leaves on bushes). The white rhinoceros is capable of going four or five days without water.

c) White Rhinos readily breed in captivity given appropriate amounts of space and food, as well as the presence of other female rhinos of breeding age.

d) Translocation costs of $30 000 are required to move each individual rhinoceros to another park system. Major conservation funding is likely to dwindle in the near future as other global warming issues become dominant.

e) The White Rhino is under threat from continual habitat loss and poaching.