

Name: _____

Section (circle one): Dan Yoram morning Yoram afternoon

ENVIR 100 Spring 2007 Final exam: 112 points total

Please do not start until you are instructed to do so.

Please do put your name on this page and circle your section.

This exam has 9 pages of questions. Each page is worth 12-14 points. At 10 minutes a page, you will finish in 90 minutes, i.e., with 20 minutes to spare.

This exam is closed-book and closed-notes. All you need is a pen or pencil.

Good luck, thanks for being part of this class, and have a great summer!

1. (12 points) These questions are about human populations.

- a. (2 points) What is the approximate human population of the United States?

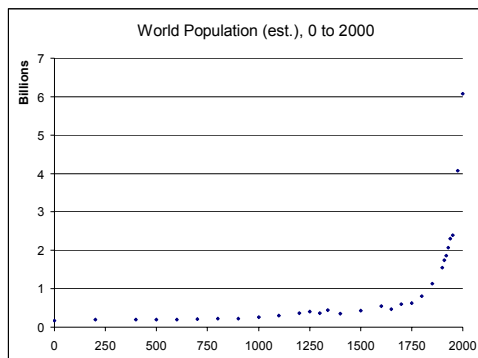
A: 300 million. Full credit for 250-350 million, 1 point for 200-400 million, otherwise 0.

- b. (2 points) What is the approximately human population of the world?

A: 6.5 billion. Full credit for 5-7 billion, 1 point for 3-8 billion, otherwise 0.

- c. (3 points) Draw a graph that roughly describes how the global human population has changed over the past 2000 years. We are not expecting you to know precise human population numbers, but your graph should have generally the right shape. *Label your axes.*

It should look roughly exponential, with years on the x-axis and population on the y-axis.



Grading: 1 point off for mislabeled axes, 2 points off for no axis labels. Full points if graph is generally in the right shape. If the curve was wrong but the axes were right they get some points, depending on how off they were.

- d. (2 points) Has human population growth over the past 2000 years been more like *linear growth* or more like *exponential growth*? (Circle one: Linear Exponential)

A: Exponential. All or nothing points.

- e. (3 points) Draw a graph that describes the *other kind* of growth. In other words: if you said that human population has been more like linear growth, draw a graph of exponential growth; if you said that human population has been more like exponential growth, draw a graph of linear growth.

Grading: 3 points for correct answer, 1 point for something like logarithmic.

2. (2 points total) The article "Plenty of gloom" made the controversial claim that most environmental scares have not panned out. Give an example of a scare that *has not* panned out (or explain that all scares have panned out).

A: Running out of food, coal, oil, etc.; 1 point for debatable answers.

3. (10 points) These questions are about the concept of "Maximum Sustainable Yield" (MSY):
- a. (3 points) Briefly describe what MSY means in the context of a fishery or a tree farm.

A: Managing the fishery or tree farm to get the maximum harvest of fish or timber each year in perpetuity; 2 points for close; 1 point for something intelligent.

- b. (2 points) Why is it difficult to apply the concept of MSY to a nonrenewable resource like a diamond mine?

A: You can't harvest the same amount each year in perpetuity; 1 point for being close.

- c. (2 points) In the case of fisheries, humankind has had trouble getting anywhere near MSY. The main reason for this is (circle one and only one):
- Biologists have had difficulty defining MSY.
 - Economists have shown that MSY is not profit-maximizing.
 - "the race for fish".

A: "Race for fish"—all or nothing points.

- d. (3 points) Briefly describe *one* of the three items above (biological difficulties, economic arguments, race for fish). Note that you *do not* need to describe the same one you circled above!

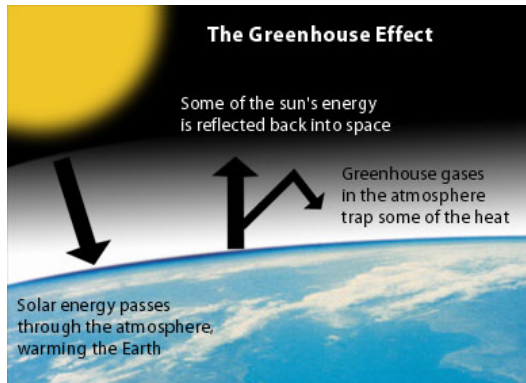
A: Biologists say that natural variability (El Nino, etc.) make it difficult if not impossible to define MSY. Economists say that MSY is not profit-maximizing because you have to compare the "fish interest rate" with the interest rate at the bank. The race for fish is the idea that an open-access fishery is like an open-access bank account: everyone will rush to pull out as much as possible, leaving nothing for the future.

Grading: 3 points for good answer, 2 points for decent answer; 1 point for something intelligent. The economic argument could involve a graph of stock size v. growth for 2 points, but for full credit there needs to be an explanation.

4. (12 points total) These questions are about climate change.

- a. (5 points) Explain in 1-3 sentences how increasing carbon dioxide concentrations in the atmosphere affect the earth's "temperature balance" and lead to climate change. *Draw a picture to illustrate your answer.*

A: Carbon dioxide forms a "blanket" that prevents solar energy from being re-radiated back into space. Here's a good picture, from <http://www.environmentalsociety.ca/issues/climate/images/greenhouse-effect.jpg>.



Grading: 2 points for drawing, 3 points for explanation. Full credit if they mention a "blanket" effect and the fact that more energy enters than leaves. Points off if explanation is unclear or inaccurate (1-2). Points off if drawing is not labeled well or is unclear (1).

- b. (3 points) "Human emissions of CO₂ are no big deal because the amount of CO₂ we emit each year (8 petagrams) will just get absorbed by terrestrial plants (45 petagrams per year) and by the oceans and aquatic plants (60 petagrams per year)." The quantities in this argument are correct, but the conclusion is not. Explain why not.

A: Terrestrial plants and the oceans are in steady-state, i.e., they emit the same amount that they absorb. Grading: 2 points for being in the ballpark, 1 point for something intelligent.

- c. (2 points) Give one example of a "greenhouse gas" other than CO₂.

A: Water vapor, nitrous oxide, CFCs, methane, etc.

- d. (2 points) Give one example of an activity other than burning fossil fuels that affects climate change.

A: Activities include deforestation, reforestation, cattle ranching, etc.

5. (8 points) Dave Montgomery gave a lecture based on his book “King of Fish.”
- a. (2 points) Which fish was he talking about? *A: Salmon. (All or nothing.)*

- b. (3 points) He discussed the “4 Hs”: harvest, hydropower, hatcheries, and habitat. Define one of these 4 Hs and describe its impact on the fish he talked about.

A: Harvest is fish catch; hydropower is dams that interfere with upstream and downstream fish travel; hatcheries is hatchery fish that compete with wild fish for resources and pollute the gene pool; habitat is good habitat for juvenile salmon (e.g., side channels to avoid floods) and other stages in the salmon lifecycle.

Impacts could involve things like having enough fish have to make it to their spawning grounds to reproduce the next generation; improving survivability for salmon at different points of its lifestyle; competition with hatchery fish; etc.

Grading: 1 point for definition, 2 points for impact.

- c. (3 points) He also discussed a “5th H”: history. Give an example of the history he was talking about.

A: Something about the history of Atlantic salmon, salmon in Great Britain, or even the history of salmon in the Northwest (e.g., that there are 5 species because they adapted to different terrain with the Cascade and Olympic Mountains); 2 points for decent answer, 1 point for something intelligent.

6. (5 points total) There have been a number of examples in class of positive feedback loops and negative feedback loops.

- a. (3 points) Give an example from class of a positive feedback loop or of a negative feedback loop. (Either one is fine.)

A: Albedo, clouds, economic feedbacks in terms of price motivating oil exploration, etc.; 2 points for decent answer, 1 point for something intelligent.

- b. (2 points) Is your example a positive or a negative feedback loop? Circle one: Positive Negative

A: Depends on example above. All or nothing points. Make sure not to confuse “positive” and “negative” feedback with “positive” and “negative” effects: the albedo effect has a negative impact on temperatures (more ice equals more reflected sunlight), but it is a positive feedback loop because cold temperature produces more ice, which (through the albedo effect) produces more cold temperatures.

7. (5 points) Circle all of the letters that apply (maybe none, maybe one, maybe more): According to *The Economist* article “The Heat Is On” and lectures from Yoram, most economists think that climate change (circle all that apply):
- a. Is a real problem that must be balanced against the needs for economic development around the world.
 - b. Is a hoax perpetrated by the same crying-wolf environmental types who were wrong about so much during the 20th century.
 - c. Is best addressed using a carbon tax or cap-and-trade system.
 - d. Is an example of how the “invisible hand” fails.
 - e. Will have massive economic effects in Washington State in this century.

A, C, and D are true. B and E are false. One point each.

8. (9 points) These questions are about oil.
- a. (3 points) Explain the difference between the amount of economically viable *reserves* of oil in the world and the amount of oil *resources* in the world. (Hint: The amount of resources is bigger.)

A: Reserves are the deposits of oil that are profitable to recover given current technology and prices. Resources are all known oil deposits, including those that are not profitable to recover given current technology and prices; minus 1 point for confusing resources with reserves; minus 2 points for only defining one of them.

- b. (2 points) If current consumption rates continue, the best guess from geologists is that there is enough oil in the world to last (circle the single best answer):
 - i. Until George W. Bush is out of the White House, but just barely.
 - ii. At least a few years, but not more than 1 or 2 decades.
 - iii. At least a few decades, but not more than 1 or 2 centuries.
 - iv. At least a few centuries, but not more than 1 or 2 millennia.
 - v. At least a few millennia, but not as long as a mountain.
 - vi. Until the sun burns out.
- c. (2 points) “The United States is one of the world’s major oil consumers.” Circle one: True False
- d. (2 points) “The United States is one of the world’s major oil producers.” Circle one: True False

A: The answer to (b) is (iii); (c) and (d) are both true. All or nothing grading for these 3.

9. (12 points total) Consider the environmental impact equation $I = P \cdot A \cdot T$ (IPAT), where I is world carbon emissions.
- (3 points) In the context of world carbon emissions, define the variables P, A, and T.
 - (3 points) Most experts think that P is very likely to increase significantly over the course of the 21st century. In approximate terms (i.e., within 15%), what is the “best guess” estimate for P in the year 2100?
 - (3 points) Most experts think that A is very likely to increase significantly over the course of the 21st century. Explain why an increase in A is generally considered to be a good thing, and then describe one reason why an increase in A might be problematic.
 - (3 points) Experts are unsure of what is going to happen to T over the course of the 21st century. If T decreases over this time period, does this mean world carbon emissions in 2100 will definitely be lower than they are today? Explain why or why not.

A: Population, affluence or economic activity (e.g., per capita GDP), technology (e.g., carbon emissions per unit of GDP). Grading: 1 point for each variable.

B: 9 billion. Grading: 3 points for 8-10 billion; 2 points for 7-11 billion; 1 point for 6-12 billion.

C: An increase in per capita GDP means that many people will be brought out of poverty. There are concerns about environmental impacts, e.g., carbon emissions. Grading: 2 points for explaining why increase in A is generally good, 1 point for explaining why increase in A can be problematic, 1 point for moderate thought effort

D: No: T needs to decrease by enough to offset the likely increase in the other variables (P and A). Grading: 1 point for “No”, 2 points for backing up No with some rational argument, 2 points for “Yes” and a correct explanation

10. (3 points each, 12 points total) Explain *four* of the following concepts or ideas. Do not explain all of them, just four! (And, of course, if you choose the you-pick option, it must be something important that we've discussed in class.)

carrying capacity

rule of 72

keystone species

anthropocentrism

biomagnification

precautionary principle

watershed

you pick!

1.

2.

3.

4.

Grading: 4 points for good answer, 3 points for minor mistake/omission; 2 points for major mistake/omission; 1 point for intelligent thought.

11. (7 points total) When two species interact, we measure the consequence of the interaction by how it affects the [??????] of the species in the interaction. These interactions can be categorized based on the benefit (+) or harm (-) resulting from the interaction.

a. (2 points) Fill in the blank from the line above:

A: population

b. (5 points) Label the following examples as +/+, +/-, or -/-.

- i. Herbivory (deer eating grass):
- ii. Sea otters and kelp:
- iii. Competition between wolves and coyotes for the same prey:
- iv. Parasitism (humans and tapeworms):
- v. Hawks and field mice:

A: +/-, +/+, -/-, +/-, +/-. All or nothing, one point each.

12. (6 points total) These questions are about environmental ethics:

a. (3 points) The field of environmental ethics was started because of concerns that (in the words of Andrew Light) “philosophy [has] contributed to the creation of environmental problems.” Explain.

A: By being so intently focused on humans and human welfare, philosophy has supported the anthropocentric activities that have created environmental problems.

Grading: 2 points for decent answer; 1 point for something intelligent.

b. (3 points) Explain how the concepts of the Evolution of Ethics and the Expanding Concept of Rights have helped address these concerns.

A: Ethics has evolved on issues such as slavery and women’s suffrage. By considering the “rights” of non-human entities, from other species to entire ecosystems, philosophy may help develop an environmental ethic.

Grading: Minus one point for only explaining one of the two concepts, or for poor answers. Two points off for major mistakes.

13. (12 points total) Catalytic converters are devices that reduce the amount of pollution produced by motor vehicles. Imagine that each of the 100,000 residents of X-ville (including you) owns a car without a catalytic converter, and that each of you has to decide whether or not to purchase one. Imagine further that (1) like your fellow X-villians, you just want to do whatever has the lowest cost for you personally; (2) it costs \$100 per car to purchase and install a catalytic converter; and (3) there are health costs related to pollution from cars without catalytic converters of \$0.01 *per person per car*. (In other words: if I don't have a catalytic converter then pollution costs from my car are a penny for me, a penny for you, etc.; if you don't have a catalytic converter either then there are additional pollution costs from your car of a penny for me, a penny for you, etc.; and so on for everybody in X-ville.)

- a. (3 points) The expected outcome of this situation is that nobody in X-ville will buy a catalytic converter. Explain why.

A: Buying a converter changes my expenses by \$100, the cost of the converter; not buying a converter changes my expenses by only \$0.01, the health costs associated with my decision to not buy a converter. Grading: 2 points for decent answer, 1 point for something intelligent.

- b. (3 points) The expected outcome from (a) is *not* an optimal outcome for this situation. Explain why, preferably by describing a better outcome .

A: It would be better for everyone to buy converters. This would involve everyone paying \$100. The alternative from (a) involves everyone incurring health costs of 100,000 times \$0.01, i.e., health costs of \$10,000. Grading: 2 points for decent answer, 1 point for something intelligent.

- c. (3 points) "The central reason that the expected outcome in (a) is not optimal is that each person must decide what to do without knowing what the other people are doing. If you knew what the others decided, you would behave differently." Do you agree with this argument? Circle one (Yes No) and briefly explain.

A: No. You have a dominant strategy, meaning that not buying a converter is in your best interest no matter what everyone else does. Grading: 1 point for "No"; 2 points for good explanation; 1 point for something intelligent.

- d. (3 points) What sort of mechanism do you suggest for reaching the optimal outcome in this game?

A: Pass a law that everyone has to have a converter. Grading: 3 points for good mechanism; 2 points for something decent; 1 point for "education" or some other concept relevant to class.