Exam #2: BIOL/ECON 140 Name: ____KEY________________________
February 27, 2009

1. Imagine a case where you have 15 units of a resource. Demand for the resource is given by P = 8 – 0.4q and the marginal cost of harvest is constant at 2. Let the discount rate be 10%. Your job is to determine how many units to consume in each period of a two period problem. The objective is to maximize welfare.
    a. (4 pts) Which of the following two equations represents the correct way to find the optimal harvest level in period 1? Explain very briefly how they differ and why one is better than the other.

i) $8 - 0.4*q = (8 - 0.4*(15-q))/1.1$ ii) $8 - 0.4*q - 2 = (8 - 0.4*(15-q) - 2)/1.1$

(ii) includes costs; (i) includes only price or WTP
Efficiency requires consideration of benefits AND COSTS – so (ii) is the better option

    b. (2 pts) How would the amount consumed in each period change if the discount rate were higher. Explain very briefly.

A higher interest rate or discount rate would result in more consumption in period 1 and less in period 2

2. Draw a diagram with price or dollars on the vertical axis and fishing effort on the horizontal axis. Show the total revenue and total cost of effort, where the diagram is based on the stock-recruitment model (i.e., recreate figure 13-5).
    a. (3 pts) Show clearly on the diagram the efficient level of effort (E*) and the level associated with the maximum sustainable yield (E_{msy}).
    b. (3 pts) Explain why the efficient level of effort is greater than or less than the effort level associated with the maximum sustainable yield.

See figure 13-5 in the text. E* occurs where the slope of the TR line equals the slope of the TC line (where the two are the farthest apart… so profit, the difference between TR and TC, is maximized). $E^* < E_{msy}$ when MC > 0. $E^* = E_{msy}$ only when MC = 0. (Keep in mind that MR = O at the peak of the TR curve…)

Draw a similar diagram to the one you constructed in problem 2 above.

c. (3 pts) Show the efficient level of effort (E^*) and the level of effort you would expect if the fishery were an open-access fishery (E_{oa}).

Again – refer to figure 13-5 in the text
E_{oa} occurs where TC = TR

d. (3 pts) To address the open-access problem you could impose a tax or set a limit on total allowable catch. Why do these forms of intervention not result in economically efficient outcomes?

These approaches do not prevent a race for fish or other examples of devoting too many resources to the fishery. (You can get the optimal stock size with these regulations, but the fish would not be harvested efficiently.)

3. This question focuses on ITQs (individually transferable quotas)
   a. (4 pts) Explain very briefly how ITQs can lead to efficient outcomes where taxes and catch limits would not.

ITQs give tradable property rights; fishers are assured of a particular catch – so they don't have to race for their harvest. Moreover, less efficient fishers can (and are expected to) sell their quotas to more efficient fishers – thereby promoting efficiency.

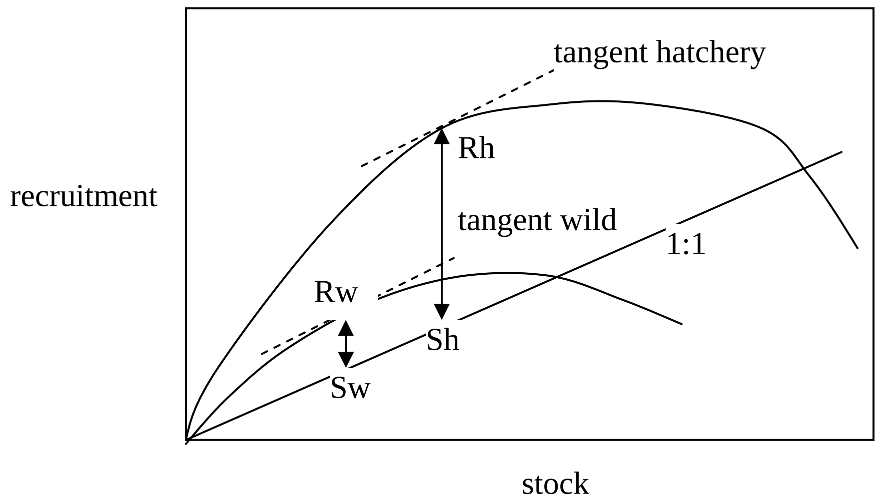
   b. (2 pts) In the end, ITQs allow fishers to catch more fish by decreasing effort. How is it possible that fishers can catch more fish with less effort?

If less effort results in a larger stock – there will be more recruits… and more recruits allows for a greater harvest. The larger stock can lower the cost of fishing or reduce the effort needed to catch fish…so you can have a greater harvest with less effort.

4. Imagine that you are a teaching assistant in BIOL/ECON 140 and you are helping to grade exam questions. One of the questions asked students to analyze the costs and benefits of a particular salmon restoration project. The readily available data shows the cost of the restoration project and the increase in salmon due to the project. The number of salmon increases for each of the next ten years, then levels off. The data also show the willingness to pay for additional fish. One student used this information to assess the project - nothing more, nothing less. As such, the benefits identified by the student include values (based on larger salmon runs) for each of the next ten years.
    a. (4 pts) What comments would you make about the students calculations for the value of additional salmon; would you recommend he/she consider anything else about the additional salmon?

Can list a variety of benefits that the student could consider.
Should mention that the benefits of more fish do not end after 10 years (something I noted when distributing the exam). You should note the concept of the counterfactual from Ch. 2 in the text. Even if the stock stops increasing after 10 years, there are still more fish than if nothing had been done… and that benefit continues into the future.

6. (6 pts) Using a Ricker stock recruitment graph, illustrate and briefly describe how setting harvest rates based on high productivity hatchery populations could lead to excess mortality of lower productivity wild populations.



The maximum exploitation rate (E) is just the proportion of fish that can be harvested at maximum sustainable yield. For the hatchery fish, Eh = (Rh-Sh)/Rh, where R = recruitment and S = stock size. For the wild fish, Ew = (Rw-Sw)/Rw. For any actual stock size, the more productive hatchery population will always have a higher exploitation rate because they always have more recruits per spawner. Harvesting at the hatchery rate will therefore drive down the population size of the wild fish.

7. In our discussion of the Elwha River dam removal, we noted that initial assessments concluded that adding fish ladders to the Elwha and Glines Canyon dams would be unlikely to improve the status of several species of salmon

a. (6 pts) Assume you were the biologist making this assessment - briefly describe at least three components of salmon life history that you would need to consider, how they are affected by the dams, and how they might differ among salmon species.

Life history components	*How affected*	*Differences among species*
Upstream migration capabilities	*Ability to climb fish ladders or not*	*Chinook, coho, steelhead – good jumpers; chum, pink - not*
Location of spawning habitat	*Inundation by reservoirs or not*	*Chum, pink inundated; others higher in watershed*
Juvenile mortality in downstream migration	*Slowed by reservoirs, direct mortality by turbines*	*Earlier/smaller outmigrants would have more difficulty with reservoirs*
Spawning productivity	*Effects of habitat quality on survival of eggs & fry*	
Some people also mentioned temperature sensitivity and susceptibility to predator aggregation, for which I gave full credit depending on completeness of the answers.		

a. (3 pts) Initial assessments of dam removal on the Elwha River found that benefits to increased sport and commercial fisheries would not outweigh costs of removal. What additional factors led to a cost-benefit balance supporting dam removal? Briefly explain.

Additional recreation opportunities afforded by dam removal. Makes the point that indirect benefits can sometimes outweigh direct benefits.

8. (6 pts) a. What is a "genetic bottleneck", what are its consequences in terms of genetic diversity, and how might it apply to hatchery management?

Genetic bottleneck – onoy a frew individuals of a population end up breeding due to random events. This could result from natural disaster or only a few individuals colonizing a new habitat.
Consequences – reduced genetic diversity and potentially different frequencies of alleles, since only a few alleles of a given gene might make it into individuals of the next generation.
Hatchery management could cause a genetic bottleneck if the broodstock consists of only a few males and females, in which case there would likely be reduced genetic diversity compared to the wild population – especially if the breeding individuals aren't chosen from across the breadth of life history strategies.

Note: genetic bottlenecks are not the same as domestication, since domestication results from <u>selection</u> for certain traits in a hatchery environment that differs from the environment in natural settings. Genetic bottlenecks (drift) happens due to <u>random</u> occurrences.

8. b.(3 pts) What are some steps that hatchery managers could take to reduce the risk of genetic bottlenecks (specifically)?

Choosing broodstock from a wide range of individuals from a variety of life history types (run timing, size at maturity, spawning location, etc.).

Note that keeping populations within watersheds is a related but different issue, since the problem that is genetic dilution of the adaptation of the home watershed population.

9. (6 pts) Currently, the Skookum Hatchery on the South Fork of the Nooksack River maintains a stock of late-run Chinook specifically for harvest. Briefly describe at least two risks for native spring-run Chinook of such a program. What specific benefits are thought to outweigh these risks and how might hatchery management help alleviate the risks?

Note: I messed up this question a bit – it's actually the Kendall Hatchery that's doing the late run Chinook for harvest, with the Skookum Hatchery (where we went) doing straight population recovery for the wild S. Fork stock. Therefore, I graded the question fairly easily, looking for reasonable application of understanding of hatchery issues and dealing with the integrated/isolated population issue, which is central to this question..

.

Risks:

- *Overlap of individuals in ocean fisheries*
- *Competition for limited habitat among wild and hatchery fry following release of latter.*
- *Genetic dilution of the native stock where spawning overlaps.*
- *Concentration of predators at release sites.*

Benefits: in this case, the major benefit is the cultural and economic importance of maintaining a tribal fishery while natural stocks are rebuilding.

Management:

- *the Skookum Hatchery is seeking to integrate the wild and hatchery S. Fork Chinook to try to bring back wild population from very low numbers (<200 spawners – 35-80 we later learned).*
- *in doing so, Skookum needs to make sure their population remains genetically distinct (isolated) from the N. Fork hatchery and wild populations.*

Some fishing issues can be dealt with by marking hatchery fish (fin clip or CWT's).
Altering release timing and location of the N. Fork hatchery fish can help eliminate overlap with wild S. Fork stocks.