

64 + 2 (E.C.)
 66/66

Exam 1

Take your time, read each question fully, and answer it succinctly to the best of your ability. The point value of each part of each question is shown in parentheses. Budget your time wisely. This exam counts for 20% of your final grade. Good luck!

1. Ecology and fish fundamentals. A. Briefly define the following terms and give a defensible example of each from the study of fish ecology (6):

Law: INVARIABLE PHENOMENON; E.G., DIGGER WATERS HAVE MORE SPECIES

6 Theory: REPEATEDLY CONFIRMED BUT GENERALLY SUPPORTIVE OF A LAW;
 E.G., COLONIZATION + SPECIATION NOTES ARE HIGHER IN DIGGER WATERS

Hypothesis: A TESTABLE STATEMENT SUPPORTING OR REFUTING A THEORY; E.G.,
 DISRUPTIVE COLONIZATION LEADS TO DECLINE IN NUMBER OF SPECIES

B. Fish first arose about 400 million years ago. The first fishes are not all that similar to most extant fishes. Give me three examples of morphological, physiological, or behavioral adaptations that distinguish ancient fishes from more modern ones (3).

- 3
- ANCIENT FISHES MORE ARMORED
 - MODERN FISHES HAVE SWIM BLADDERS
 - MODERN FISHES HAVE BUSTLED DIVINGLY & MOUTH FUNNEL
- THE MOST ANCIENT FISHES WERE JAWLESS
- FISHES BREATHE IN OCEAN; FISHES NOW LIVE IN "AIR" THROUGH LUNGS

2. The nature of adaptation. Adaptation can be conceived as occurring at two levels. A. In a sentence, how do *individuals* adapt to environmental stressors through their lifetime (2)? Give me an example (1).

3 - CHANGE PHENOTYPE (MOSTLY PHYSIOLOGY OR BEHAVIOR) TO Cope WITH A STRESSOR. ON ANNUAL CYCLES, MOLT TO CHANGES IN WATER TEMPERATURE.

B. How do populations adapt to environmental forces over the generations (2)? Give me an example (1).

3 - CHANGES IN GENOTYPE FREQUENCIES AT POPULATION LEVEL TO Cope WITH SELECTIVE FORCES. UPON ¹⁷⁵SELECTIVE FISHING, SALMONIDS IN SPECIFIC NORTHWEST MOUNTAIN FAMILIES + SMALLER NOW THAN PREVIOUSLY.

C. Which process is faster (1)? Which process has the potential for a greater degree of adaptation (1)?

2

INDIVIDUAL-LEVEL, PHENOTYPIC CHANGE

POPULATION-LEVEL, EVOLUTIONARY CHANGE

3. Water as an environment. Water's unique properties are key to supporting aquatic life. A. Why is it important that water has a high specific heat, i.e., why is this important for fishes (2)?

2 WATER WILL HEAT OR COOL ONLY SLOWLY, ALLOWING FISHES TO ADAPT PHYSIOLOGICALLY TO NEW TEMPERATURES. ΔT slow temp

B. Why is it important to aquatic life that water molecules arrange in tetrahedrons upon transition to the solid phase (2)?

2 AS WATER FREEZES, IT EXPANDS. ICE FLOATS, LEAVING A THERMAL BARRIER BELOW FOR AQUATIC LIFE. Ice floats \rightarrow thermal

C. Why is it important to all life that water is a good solvent (2)?

2 WATER IS THE MOST EFFECTIVE MEDIUM FOR EXCHANGE OF DISSOLVED GASES, IONS, + OTHER COMPOUNDS IN AND OUT OF CELLS. gases ions toxins

4. Adaptations to particular ways of life. Fishes have adapted to extreme environments such as the deep sea and deserts. Give me an example of how they adapted to each of the selective forces I set out below (1 pt each):

A. Deep sea: Depth: GAS BLOOD WITH RETE MIRABILIS

Dark: EYES HAVE LOTS OF RODS (OR BLIND); EXCELLENT LATERAL LINE

Scarcity of food: REDUCES NEURON THICKNESS, AMAZING TONGUE JAWS, ...

Rarity of mates: MALES BIND OFF FEMALES (SQUIDENGIN)

B. Desert environments: Limited availability of dissolved oxygen in warm water: UNPAIRED MOUTH, AIR-BREATHING ABILITY (LUNGS, VASCULARIZED MOUTH, ...)

Seasonal drying: ANNUAL LIFE CYCLE WITH DIAPYCNIS AT EGG STAGE (COMMON CYCLOPODONT-FISHES) RESTRICTION (LUNG-FISHES)

5. Eating and avoiding being eaten. A. Below, five major feeding guilds of fishes are listed on the left and three feeding adaptations are listed on the right. For each adaptation, choose the best-matching guild (3).

- a. macropredators 1 "inferior" lips
- b. grazers 3 molariform pharyngeal teeth
- c. filterers/strainers 2 strong stomach acid
- d. suckers
- e. parasites

B. Below, four tactics fishes use to avoid being eaten by predators are listed on the left and three avoidance adaptations are listed on the right. For each adaptation, choose the best-matching tactic (3).

- | | | | |
|---|------------------------|--------|--------------------|
| } | a. Hide | 5 | bright coloration |
| | b. look dangerous | c | deep body |
| | c. be difficult to eat | d of d | schooling behavior |
| | d. avoid predators | | |

6. Reproduction. A. In our recent quiz, we mentioned that, regarding fitness, females are egg-limited and males are mate-limited. OK, then, what are three morphological, physiological, or behavioral adaptations by which males seek to increase the number of matings (3):

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- BE ORIGINALLY CALLED bright colors large size
 - DOMINATE ACCESS TO SPAWNING TERRITORY control access to spawn site
 - DO A SPAWNING "DANCE" TO ADVERTISE YOUR FITNESS TO A MATE display convincingly

B. Some fishes spawn only once in their lifetime but others spawn multiple times. Describe a main advantage and disadvantage of spawning multiple times (2).

- 2
- Adv: ^{hedge bet} HEDGE YOUR BETS increase total offspring
- Dis: YOU MAY DIE BEFORE HAVING A SECOND CHANCE TO SPAWN
may die before next chance

7. Migration. A. In the quiz, we asked why *not* to migrate. Well, then, against the background of the costs, give me three reasons why some fishes **DO** migrate (3):

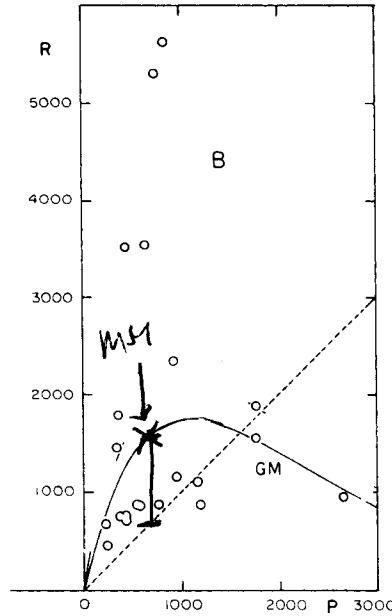
- }
- SPAWN IN PLACE WHERE YOU MOST LIKELY TO RECRUIT seek nursery habitat
 - seek ^{abundant food} MIGRATE TO PLACE WHERE FOOD IS ABUNDANT → RAPID GROWTH IN INCREASING STAGE
 - TAKE ADVANTAGE OF REFUGE FROM PREDATORS, FLOOD, ... seek refuge

B. How would the construction of dams (without fish ladders) affect the relative frequencies of the two alternative life history strategies of sockeye salmon, the migratory "salmon" and the non-migratory "kokanee". Explain your answer (3).

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DAM FAVORS KOKANEE AS THEY CAN COMPLETE LIFE CYCLE
LOCALLY, WHILE SALMON MUST PASS DAMS IN DOWNSTREAM
+ UPSTREAM MIGRATION. SALMON WOULD DECREASE IN FREQUENCY.
dams favor kokanee; salmon must migrate (2 directions)

8. Population dynamics and stock recruitment. Shown is the stock recruitment curve for Tillamook Bay chum salmon from Ricker (1987).



A. What does the dashed diagonal line represent (1)?

EQUAL REPLACEMENT OF SPAWNS WITH NEW RECRUITS.

B. What do each of the data points, the round dots, represent (1)?

ONE YEAR OF DATA RELATING # SPAWNS TO SUBSEQUENT # OF RECRUITS

(6)

C. What does the curved line GM represent (2)?

THE FIT OF A CURVE TO ALL THE DATA POINTS \Rightarrow STOCK RECRUITMENT RELATIONSHIP

D. Mark the point of maximum yield to the fishery, and explain your choice of location (2).

MSY ABOVE

GREATEST SEPARATION BETWEEN STOCK RECRUITMENT CURVE + EQUAL REPLACEMENT LINE

Extra credit: As a fisheries manager, should I be concerned by the observation that the data points are so scattered? Why or why not (2)?

YES. THERE IS MUCH UNCERTAINTY ASSOCIATED WITH THIS PREDICTION OF YIELD THAT I'M MAKING, THAT I MIGHT FACE ON CIRCUMSTANCES MANY CHANGE TO POINT THAT WE OVERHARVEST.

(6) * 2

9. Life history strategies. A dam project is planned that will affect a small river on which you work. You are examining a poorly-known species that occurs there. Upon examination, you note that adults are smallish, 5 cm total length; they mature in their second year; in June, ovaries bear eggs of differing degrees of readiness; and marked individuals live at least four years.

A. Explain what life history strategy this species exhibits (opportunistic, periodic, equilibrium) and how you know (2).

2 PERIODIC. ADAPTED TO SPAWN MULTIPLE TIMES ~~OVERSEAS~~ OVER SEVERAL YEARS TO ULTIMATELY SPAWN IN A GOOD TIME, YIELDING RECAVITY

B. Name two sorts of life history observations you would seek to corroborate or refute your choice in part A (2).

- 2
- LOOK FOR ERRATIC RECRUITMENT ALL TIME (clutch size)
 - LOOK FOR SYNCHRONOUS SPawning ACROSS POPULATION
 - NO PARENTAL CARE

C. If the project goes forward and a dam is built on this river, explain how the associated habitat alteration would affect this species (2).

2 IF CRITICAL HABITAT IS LOST, THIS SPECIES' VIABILITY MAY BE ^{loss of habitat ↓} COMPROMISED. THEY CANNOT ADAPT WELL TO LOSS OF HABITAT ^{↓ reduced viability} + TEMPORAL VARIATION. WILL LOOK OUT TO MOVE COMPETITIVE SPECIES ADAPTED TO NEW LAKE OR FLOW REGIME. ^{may not adapt well} MAY BE DISPLACED BY SPECIES BETTER ADAPTED TO NEW ENVIRONMENT

10. Metapopulation dynamics. What is a metapopulation (2)?

B. Describe two main differences between "rescue" metapopulations and "mainland-island" metapopulations (2).

- 2
- RELATIVE SIZES OF DEMES: EQUAL IN CLASSICAL UNEQUAL IN M-I ^{groups of distinct pops linked by dispersal}
 - DISPERSAL PATTERN: OMNIDIRECTIONAL IN CLASSICAL ^{dispersal rate: higher in rescue} ONLY FROM MAINLAND + ISLANDS IN M-I

C. If I suspect that a particular species has metapopulation structure, briefly, how would I go about demonstrating that (2)?

- 2
- DEMONSTRATE POPINS
 - DOCUMENT DEMOGRAPHIC INTERCHANGE
 - EXAMINE HABITAT PATCH OCCUPANCY
 - TAGGING + MOVEMENT STUDIES
 - GENETIC DIFFERENTIATION STUDIES

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