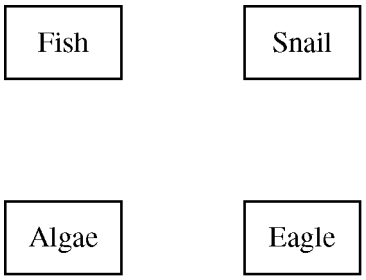
4. Wetlands were once considered to be wastelands. Over 50 percent of the United States original wetlands have been destroyed.

   (a) Describe TWO characteristics that are used by scientists to define an area as a wetland.

   (b) Wetlands are highly productive ecosystems with complex food webs.

      (i) Complete the diagram of the wetland food web below by drawing arrows that show the direction of energy flow.



      (ii) Explain why it takes many hectares of wetland to support a pair of eagles.

   (c) Describe TWO economic benefits (other than those related to water quality) that wetlands provide.

   (d) Describe one specific human activity that degrades wetlands.

   (e) Wastewater treatment plants perform some of the same water-quality improvement functions that natural wetlands perform. Explain how wetlands perform the equivalent of

      (i) primary treatment, and

      (ii) secondary treatment.

STOP

END OF EXAM

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Question 4

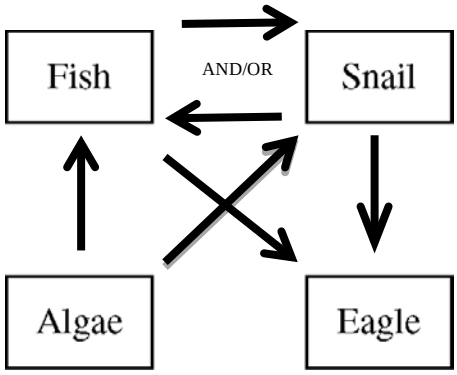
Wetlands were once considered to be wastelands. Over 50 percent of the United States original wetlands have been destroyed.

(a) Describe TWO characteristics that are used by scientists to define an area as a wetland.
(*2 points: 1 point for each characteristic; only the first two characteristics mentioned can earn points*)

- Soil covered/saturated/submerged/inundated/flooded with water (for all or part of the year) OR shallow/standing water with emergent vegetation.
- Plants/vegetation have adaptations that allow them to live under these conditions (are water tolerant).
- Characteristic (hydric) soils.

(b) Wetlands are highly productive ecosystems with complex food webs.

(i) Complete the diagram of the wetland food web below by drawing arrows that show the direction of energy flow.
(*2 points: Three arrows are required. ALL boxes must have at least one connecting arrow, and no points are earned if ANY arrows are incorrect. One point can be earned for at least two correct arrows indicating a food chain, and 1 additional point can be earned for creating a food web connecting two food chains that share a species in common*)



(ii) Explain why it takes many hectares of wetland to support a pair of eagles.
(*2 points: 1 point for each correct explanation*)

- To support a pair of eagles, there must be a large amount of biomass at lower trophic levels.
- Less energy is available at each successive trophic level, because as energy moves up the food chain, much of it is:
  - lost as heat (10 percent rule) or lost as metabolic work; or,
  - transformed into a less usable form/becomes less organized (second law of thermodynamics).
- Some biomass is not digestible at the next trophic level (e.g., cellulose, chitin). *Note:* Students may use a trophic pyramid diagram, but it must be accompanied by an explanation in order to earn credit.

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Question 4 (continued)

(c) Describe TWO economic benefits (other than those related to water quality) that wetlands provide.
(*2 points: 1 point for each economic benefit LINKED to each description; only first two descriptions provided can earn points*)

Acceptable benefits include, but are not limited to, the following:

Benefit	Description
Recreation/aesthetic uses	• Provide revenue/profits/jobs from tourism • Provide revenue from permits/hunting/fishing licenses
Nurseries for fish and shellfish species/areas for aquaculture	• Provide fish/shellfish for sale by commercial fishers
Absorption of excess water	• Reduces cost of flood damage to property (roads, buildings, other infrastructure, crops) • Reduces insurance costs
Storm protection	• Reduces cost of hurricane/tsunami damage • Reduces insurance costs
Protection of biodiversity	• Provides jobs in conservation/biological resources management
Carbon sequestration/sink	• Reduces cost of mitigating effects of climate change
Methane collection	• Provides revenue
Provide water supply (particularly during periods of drought)	• Supports revenue from agricultural crops • Lowers costs for irrigation • Reduces the need to build costly dams
Used for agriculture	• Commercial species/trade (such as wild rice, cranberries, blackberries, blueberries)
Shoreline stabilization/erosion protection	• Reduces financial loss associated with rising sea level (agriculture/development) • Reduces insurance costs
Extraction of products (fossil fuels, phosphate/fertilizer, peat, gravel, building materials, minerals, wood/timber)	• Revenue/profits from sale/trade
Recharge ground water	• Reduces cost of water treatment (infrastructure/transportation/desalination/reverse osmosis)

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Question 4 (continued)

(d) Describe one specific human activity that degrades wetlands.
(*1 point: only the only first description provided can earn points*)

- Converting to other uses (draining/filling)
  - Agriculture
  - Buildings/infrastructure/development
- Runoff/urban storm water drainage
  - Sediment
  - Chemical pollutants: fertilizer, pesticides, heavy metals, oil
  - Sewage
  - Litter/trash/solids
- Disposing of waste such as dumps/landfills/livestock waste (e.g., hog lagoons)
- Overharvesting/poaching
  - Commercial fishing
  - Recreational hunting and fishing
- Logging/deforestation/removal of trees to allow alternative use of the wetland or for sale of timber
- Recreational vehicles
  - Disturb sediment/bottom
  - Damage aquatic vegetation
  - Injure/kill organisms
  - Produce noise pollution
- Water diversion
  - Damming/levees/building barriers to control/change water flow/levels
  - Diking/building barriers to control rising sea level
  - Use for water supply (irrigation, municipal, industrial)
- Dredging/channelization for navigation
- Anthropogenic acid precipitation from fossil fuel (coal) burning
- Oil spills from tankers/drilling platforms/transportation
- Waste disposal/habitat destruction associated with recreational activities
  - Fishing and hunting activities
- Mining for minerals, fossil fuels, building materials, or peat
- Draining to reduce mosquito populations/malaria
- Human-induced sea level rise (climate change)
- Conversion to commercial aquaculture facilities
- Introduction of invasive species

(e) Wastewater treatment plants perform some of the same water-quality improvement functions that natural wetlands perform. Explain how wetlands perform the equivalent of

(i) primary treatment, and
(*1 point: only the first explanation provided can earn points*)

Physical/mechanical removal/trapping of sediment/solids/objects/particulates through processes such as settling, sedimentation, filtering, and screening.

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Question 4 (continued)

(ii) secondary treatment
(*1 point: only the first explanation provided can earn points*)

Biological/bacterial/microbial removal of waste through breakdown, decomposition, and aerobic respiration/consumption.

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