

# AP<sup>®</sup> ENVIRONMENTAL SCIENCE 2012 SCORING GUIDELINES

## 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.**

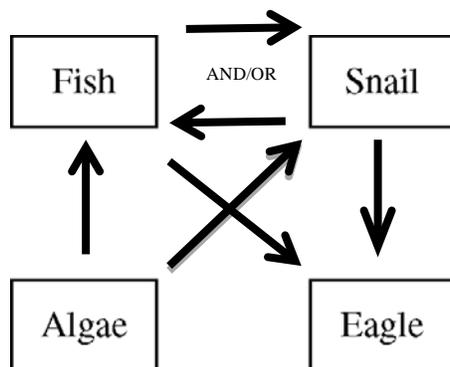
*(2 points: 1 point for each characteristic; only the first two characteristics mentioned can earn points)*

- 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:

<b>Benefit</b>	<b>Description</b>
Recreation/aesthetic uses	<ul style="list-style-type: none"> <li>• Provide revenue/profits/jobs from tourism</li> <li>• Provide revenue from permits/hunting/fishing licenses</li> </ul>
Nurseries for fish and shellfish species/areas for aquaculture	<ul style="list-style-type: none"> <li>• Provide fish/shellfish for sale by commercial fishers</li> </ul>
Absorption of excess water	<ul style="list-style-type: none"> <li>• Reduces cost of flood damage to property (roads, buildings, other infrastructure, crops)</li> <li>• Reduces insurance costs</li> </ul>
Storm protection	<ul style="list-style-type: none"> <li>• Reduces cost of hurricane/tsunami damage</li> <li>• Reduces insurance costs</li> </ul>
Protection of biodiversity	<ul style="list-style-type: none"> <li>• Provides jobs in conservation/biological resources management</li> </ul>
Carbon sequestration/sink	<ul style="list-style-type: none"> <li>• Reduces cost of mitigating effects of climate change</li> </ul>
Methane collection	<ul style="list-style-type: none"> <li>• Provides revenue</li> </ul>
Provide water supply (particularly during periods of drought)	<ul style="list-style-type: none"> <li>• Supports revenue from agricultural crops</li> <li>• Lowers costs for irrigation</li> <li>• Reduces the need to build costly dams</li> </ul>
Used for agriculture	<ul style="list-style-type: none"> <li>• Commercial species/trade (such as wild rice, cranberries, blackberries, blueberries)</li> </ul>
Shoreline stabilization/erosion protection	<ul style="list-style-type: none"> <li>• Reduces financial loss associated with rising sea level (agriculture/development)</li> <li>• Reduces insurance costs</li> </ul>
Extraction of products (fossil fuels, phosphate/fertilizer, peat, gravel, building materials, minerals, wood/timber)	<ul style="list-style-type: none"> <li>• Revenue/profits from sale/trade</li> </ul>
Recharge ground water	<ul style="list-style-type: none"> <li>• Reduces cost of water treatment (infrastructure/transportation/desalination/reverse osmosis)</li> </ul>

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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)*

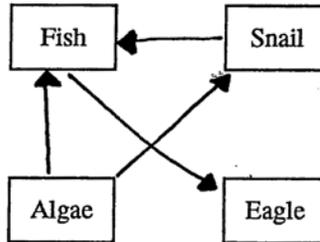
Biological/bacterial/microbial removal of waste through breakdown, decomposition, and aerobic respiration/consumption.

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. *saturated w/ water*

(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. *2nd Law of thermodynamics conservation*

(c) Describe TWO economic benefits (other than those related to water quality) that wetlands provide. *ecosystem conservation, trophic levels, habitat for organisms*

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

*drainage for agriculture*

*good farming - more tourism??*

(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.

a) An area is a wetland if the soil is annually saturated with water. Moreover, wetlands tend to have pure water and soil that is highly rich in nutrients. If the area meets both of these characteristics, scientists define the area as a wetland.

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b) (i) The second law of ~~thermodynamics~~ <sup>thermodynamics</sup> states that when energy is transformed from one form to another, some is lost as heat. As one moves up the trophic pyramid, only 10% of the energy is retained at each level. Therefore, ~~the~~ tertiary consumers need to eat a lot more and require much more energy than the producers at the bottom of the pyramid.

c) Wetlands provide soil extremely rich in nutrients, and therefore are often good for agriculture. Soils that ~~are~~ have more nutrients often have a larger crop yield, which leads to more money for the farmer. Moreover, wetlands can be a tourist attraction due to the richness of their biodiversity. Tourism brings in money for the surrounding towns, and is therefore good economically.

d) Humans often drain the water from wetlands for agriculture or for domestic use. Since wetlands are classified by ~~the~~ the saturation of the soil by water, ~~the~~ when the water is drained the organisms cannot adapt and the wetland is destroyed.

e) (i) The soil in wetlands filters out many of the larger particles, and therefore acts as ~~the~~ primary treatment.

(ii) Bacteria in the wetlands act as secondary treatment by removing the smaller parts of organic matter that ~~the~~ passed through the original filtration.

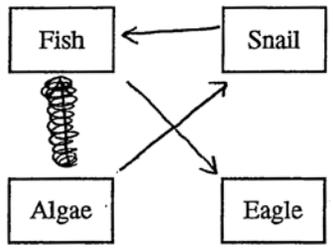
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(d) Describe one specific human activity that degrades wetlands.

(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.

a) A characteristic to define an area as a wetland ~~is~~ would be the soil composition; how much of the soil is clay, how much is sand, and how much is silt. Another characteristic to define a wetland is its location to a major source of water such as an ocean and the amount of rivers or bodies of water that flow into the wetland. Salinity also plays a part!

b) ii) Eagles are at the top of the food chain and as energy is passed from one trophic level to the next only 10% of the energy is passed along the other 90% is lost (2<sup>nd</sup> Law of Thermodynamics). Therefore, in order for eagles to gain enough energy they must eat 1 ton of fish, because they are only receiving 10% of the energy

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that the fish had.

c) An economic benefit that wetlands provide is a source of income for fishers. People can fish in the wetlands, catch fish, and then sell the fish in the market to make money. Another economic benefit that wetlands provide is a tourist attraction. Tourists can come and see wetlands; ~~perhaps~~ perhaps take a boat bringing revenue to area.

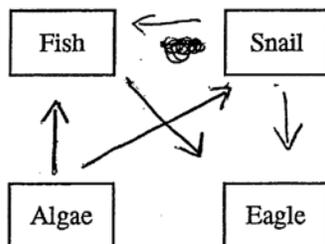
d) A human activity that degrades the wetlands would be the use of synthetic fertilizers. Applying fertilizers to plants can be carried off by runoff and then enter the watershed. Once the fertilizers enter the watershed, the excess of nutrients such as phosphorus can lead to algal blooms like eutrophication.

e) i) In primary treatment the large, solid wastes are removed such as paper product, human waste, and large rocks and sticks. A wetland has a buffer zone full of plants and vegetation that collect the large, solid wastes that are carried with the runoff water. The plants and vegetation in the buffer zone catch all the big particles before entering the true wetland.

ii) In secondary treatment the organic material is removed from the water. Wetlands have bacteria and organisms that consume the organic material in the runoff water, thus cleansing the water and removing dangerous particles like phosphorus and nitrogen.

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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.

Scientists define areas as wetlands if they include plants such as reeds that are partially submerged in water. Wetlands are also defined by their ability to filter contaminated water. Plants in this biome have the ability to remove toxins.

It takes many hectares of wetland to support a pair of eagles because these eagles rely on

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primary consumers such as fish, which in turn rely on producers such as aquatic plants for food. ~~So~~ The amount of biomass is largest at the lowest trophic level, & since eagles are consumers that are at a high trophic level, they require the biomass from the lower levels to support them, which takes up a lot of space. ~~One~~ <sup>one</sup> economic benefit of wetlands is that they can raise revenue from tourism. For example, many tourists visit the Everglades in Florida. A second benefit is that scientists & universities may pay to test water quality & observe native species in wetlands, which can raise revenue for the state they are located in.

one human activity that degrades wetlands is the construction of residential & commercial areas. This construction destroys the natural balance within this biome & eradicates species such as turtles & egrets from their native habitat.

Wetlands perform the equivalent of primary treatment by removing solid wastes from contaminated water through the process of decomposition.

They perform the equivalent of secondary treatment by filtering organic material & nutrients such as Nitrogen & Phosphorus from the water. This filtration, which is done by aquatic plants, helps improve

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## 2012 SCORING COMMENTARY

### Question 4

#### Overview

The intent of this question was to ascertain students' knowledge of wetland ecology, including characteristics of wetlands, wetland food webs, energy conversions in these food webs, economic benefits provided by wetlands, how human activities have degraded wetlands, and how wetlands perform functions that mimic primary and secondary treatment of wastewater.

#### Sample: 4A

**Score: 10**

In part (a) 1 point was earned for stating that “the soil is annually saturated with water.” Two points were earned in part (b)(i) for drawing one food chain with three organisms (algae to snail to fish) and an additional food chain (algae to fish to eagle), which shows the understanding that a food web consists of multiple food chains, which in turn demonstrates knowledge of energy flow in a food chain and that a food web is more than just one food chain. One point was earned in part (b)(ii) for noting that “[t]he second law of thermodynamics states that when energy is transformed from one form to another, some is lost as heat.” An additional point was earned in part (b)(ii) for stating that “tertiary consumers need to eat a lot more and require much more energy than the producers at the bottom of the pyramid.” One point was earned in part (c) for stating that wetlands contain soils that produce “a larger crop yield, which leads to more money for the farmer.” An additional point was earned in this part for stating that “[t]ourism brings in money.” One point was earned in part (d) for describing the degradation of wetlands by draining them for agriculture. In part (e)(i) 1 point was earned for describing how — as in primary treatment, which is a physical process — wetlands filter out larger particles. An additional point was earned in part (e)(ii) for stating that wetlands mimic secondary treatment in that they have bacteria that remove organic matter.

#### Sample: 4B

**Score: 8**

In part (a) no points were earned for stating that “soil composition” describes a wetland or that wetlands are located near large bodies of water, because these characteristics are both too general. Two points were earned in part (b)(i) for drawing a food chain with three organisms (algae to snail to fish) and an additional food chain (fish to eagle), which shows the understanding that a food web consists of multiple food chains, which in turn demonstrates knowledge of energy flow in a food chain and that a food web is more than just one food chain. One point was earned in part (b)(ii) for stating that “as energy is passed from one trophic level to the next only 10% of the energy is passed along the other 90% is loss [*sic*].” Two points were earned in part (c) for stating that wetlands provide “a source of income for fishers” and that tourists bring revenue to the area. One point was earned in part (d) for stating that applying fertilizers that can be carried away by runoff is a human activity that degrades wetlands. One point was earned in part (e)(i) for describing how “plants and vegetation” collect “large, solid wastes,” which mimics the physical screening in primary treatment. An additional point was earned in part (e)(ii) for stating that “bacteria . . . consume the organic material,” which mimics the biological processes in secondary treatment.

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## Question 4 (continued)

**Sample: 4C**

**Score: 6**

One point was earned in part (a) for stating that wetlands contain “plants such as reeds that are partially submerged in water.” No point was earned in this part for noting wetlands’ ability to filter water, because this is an ecosystem service of wetlands, not a characteristic. Two points were earned in part (b)(i) for drawing a food chain with three organisms (algae to snail to fish) and an additional food chain (algae to snail to eagle), which shows the understanding that a food web consists of multiple food chains, which in turn demonstrates knowledge of energy flow in a food chain and that a food web is more than just one food chain. One point was earned in part (b)(ii) for stating that “[t]he amount of biomass is largest at the lowest trophic level.” One point was earned in part (c) for stating that wetlands “raise revenue from tourism,” but no additional point was earned in this part for explaining that universities pay to test water quality in wetlands, because this is not limited to wetlands. One point was earned in part (d) for describing how “construction of residential & commercial areas” destroys wetlands. No points were earned in part (e), because solids are not removed through decomposition in primary treatment, and secondary treatment does not involve filtering of organics.