
AP Environmental Science

Sample Student Responses and Scoring Commentary

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**AP[®] ENVIRONMENTAL SCIENCE
2017 SCORING GUIDELINES**

Question 4

Dams are built by humans for various purposes including hydroelectric power generation and control of downstream flooding.

- (a) **Explain** how electricity is generated at a hydroelectric dam.

(3 points: 1 point for a description of each step in the process of generating electricity at a hydroelectric dam.)

Step	Description of Step
Water moves	<ul style="list-style-type: none">• Water falls/drops• Water is directed to a turbine• Potential energy → kinetic energy
Turbine rotates	<ul style="list-style-type: none">• Water turns/rotates a turbine• Kinetic energy → mechanical energy
Electricity produced	<ul style="list-style-type: none">• Turbines turn/drive a generator• Rotation converted to electricity• Mechanical energy → electricity

- (b) **Identify** TWO economic benefits, other than hydroelectric power generation and control of downstream flooding, associated with dams.

(2 points: 1 point for each correct identification of an economic benefit. Only the first two identifications can earn a point.)

- Recreation/tourism
- Job creation
- Provision of water for domestic, industrial, or agricultural use
- Commercial fisheries
- Commercial shipping

- (c) **Describe** one ecological benefit of seasonal flooding of the floodplain of a free-flowing river.

(1 point for a correct description of an ecological benefit of seasonal flooding of the floodplain.)

- Flooding can deposit nutrients/increase soil fertility
- Sediment can create banks
- Sediment can build/replenish soil
- Overflow can deposit seeds
- Flooding can recharge the aquifer
- Overflow can create/maintain habitat for fish and birds (e.g., riparian zones, wetlands)
- Flooding can decrease soil/water salinization

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Question 4 (continued)

(d) Some dams have been removed from rivers.

(i) **Explain** how removal of a dam can benefit fish populations.

(1 point for correct explanation of how dam removal benefits fish populations.)

- Restoration of wetland/riparian habitats supports fish populations
- Removal of barrier allows fish migration/increases access to habitats/mates
- Removal of dam turbines/spillway decreases fish mortality
- Restoration of pre-dam conditions (e.g. water temperature, habitat, dissolved oxygen, turbidity) benefits native species

(ii) **Describe** one negative environmental consequence of removing a dam from a river (other than effects on fish populations).

(1 point for correct description of a negative environmental consequence of dam removal.)

- Loss of lake habitat/species or downstream habitat/species following restoration of pre-dam conditions
- Increased deposition of sediment downstream
- Erosion of stream banks by high flow following rapid dam removal
- Increased turbidity from release of silt/sediment
- Movement of pollutants accumulated behind the dam downstream
- Change of water temperatures downstream
- Spread of invasive species

(e) Dams are also built by beavers, a keystone species in some North American ecosystems.

(i) **Define** keystone species.

(1 point for a correct definition of a keystone species.)

- Has a large effect on its environment relative to its abundance
- Increases ecosystem stability OR reduces ecosystem stability when absent

(ii) **Describe** how dams built by beavers can make beavers a keystone species in some ecosystems.

(1 point for a description of how beaver dams transform their environment linked to impact on other species.)

- Creation of habitats/alteration of existing habitat
- Fewer floods maintains habitat stability
- Removal of water-borne pollutants increases survival of aquatic life
- Entrapment of sediments behind dam creates habitat/reduces turbidity
- Reduction of erosion of stream banks

4. Dams are built by humans for various purposes including hydroelectric power generation and control of downstream flooding.
- Explain** how electricity is generated at a hydroelectric dam.
 - Identify** TWO economic benefits, other than hydroelectric power generation and control of downstream flooding, associated with dams.
 - Describe** one ecological benefit of seasonal flooding of the floodplain of a free-flowing river.
 - Some dams have been removed from rivers.
 - Explain** how removal of a dam can benefit fish populations.
 - Describe** one negative environmental consequence of removing a dam from a river (other than effects on fish populations).
 - Dams are also built by beavers, a keystone species in some North American ecosystems.
 - Define** keystone species.
 - Describe** how dams built by beavers can make beavers a keystone species in some ecosystems.

~~a) As the water is blocked~~

a) As the water is allowed to flow through the dam at a controlled rate, the water turns a ^{turbine} generator which then runs an electric generator thus, producing electricity.

b) The dam provides recreation or arena for recreational activity such as fishing and jetskiing which brings in revenue to that society. People go to the dam and pay to do different water sports thus helping the economy. The dam also provides jobs ~~with the dam~~ during the construction of the dam and then afterwards the running of the dam therefore lowering unemployment rates and helping the economy.

c) It provides nutrients from the river to the floodplain thus creating fertile soil that many plant organisms thrive in which then allows for animals to come in also and feed on these plants then

ADDITIONAL PAGE FOR ANSWERING QUESTION 4

more animals come to feed on those animals thus creating a complex food web and a high species richness in those flood plains.

d) i. It allows them to freely swim ~~upstream~~ down stream unblocked by the dam thus opening up new niches for them to fill and thrive in.

ii. All the sediment that was blocked by the dam is released, and this includes the build up of all the ~~toxic~~ toxic chemicals and pollutants, resulting in the toxicification of downstream and technically the ~~re-releasement~~ re-releasement of pollutants in to the environment. When ~~settling~~ blocked by the dam the pollutants were ~~not~~ settled and did not affect the environment but as soon as the dam is removed these pollutants are "let loose" into the environment, wreaking havoc.

e) i. A species that in an ecosystem that stabilizes the ^{ecosystem} environment which when absent, leads to the complete destruction of said ecosystem. They fill an important ecological role ~~the~~ and when they are no longer present, that role is not filled and the ecosystem falls apart.

ii. These dams change the course and function of a river, ~~which~~ actually making it ~~in~~habitable for many species and when ~~the~~ beavers disappear their dams fall apart as well, allowing for the river to revert back to its original state, ~~and~~ therefore making it uninhabitable for many species and leading to the ~~destruction~~ destruction of what had been a thriving ecosystem. The fact that the absence of the beaver and its dams leads to the destruction of the ecosystem is ~~also~~ what makes it a keystone species because that is the definition of a keystone species.

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4. Dams are built by humans for various purposes including hydroelectric power generation and control of downstream flooding.
- Explain** how electricity is generated at a hydroelectric dam.
 - Identify** TWO economic benefits, other than hydroelectric power generation and control of downstream flooding, associated with dams. *Jobs, activities generated*
 - Describe** one ecological benefit of seasonal flooding of the floodplain of a free-flowing river. *vernal pools*
 - Some dams have been removed from rivers.
 - Explain** how removal of a dam can benefit fish populations. *may flourish*
 - Describe** one negative environmental consequence of removing a dam from a river (other than effects on fish populations). *Washout*
 - Dams are also built by beavers, a keystone species in some North American ecosystems.
 - Define** keystone species. *integral* 
 - Describe** how dams built by beavers can make beavers a keystone species in some ecosystems. *ponds*

a) At a hydroelectric dam, water passes over an impiment, which turns a turbine, which creates electricity.

b) One economic benefit from building a dam is the creation of jobs to build and maintain it. Another is the use of the reservoir and subsequent waters for recreational activity ^{which} generates money for the local area.

c) Seasonal flooding can create seasonal pools, also ~~referred~~ ^{referred} to as vernal pools. These provide breeding and nursery habitats for a variety of aquatic species, such as frogs and Salamanders.

d) i. Removing a dam can benefit a fish population by allowing anadromous species to go upstream to spawn.

ii. Removing a dam from a river can in turn create rapid flows which can washout banks and structures downstream. This massive erosion can harm humans and animals alike.

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e) i. A keystone species is a species whose presence is necessary for other organisms to live.

ii. Beavers building dams in turn create ponds which provide habitat for numerous species, for example fish and muskrats. This slow moving water is crucial for these species to thrive.

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 - Describe** how dams built by beavers can make beavers a keystone species in some ecosystems.

A. Water on ~~the~~ the upstream side of the dam is built up in a reservoir, and then water in a reservoir flows through turbines and turns turbines, which produces ~~power~~ electrical power.

B. Dams such as the Hoover Dam are tourist attractions, and tourism generates money for the surrounding businesses. Using water to generate power is also cheaper than having to drill, refine, and transport oil.

C. When rivers flood, nutrient-rich sediment gets deposited along ~~the~~ floodplains, which is ideal for increase soil quality and plant growth.

D. Removal of a dam can allow fish population such as salmon carry out their natural migration upstream to spawn.

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The removal of a dam then places more strain on nonrenewable energy sources such as coal and oil. The combustion of fossil fuels then leads to carbon emissions that are detrimental to the atmosphere and the environment.

E. I. A keystone species ^{is} any species in an environment that has significant roles in the stability of an environment.

II. Dams built by beavers can also limit fish migration patterns. However, since they occur naturally, and aren't man-made, the beaver dams control the fish population ~~to~~ to a degree that is sustainable to the health of the rest of the environment and ecosystem.

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Question 4

Overview

The question was intended to measure students' knowledge regarding the generation of electricity at a hydroelectric dam, the impact of dam removal on a river ecosystem, and of the role of keystone species. Students were asked to explain how electricity was generated at a hydroelectric dam. Students were then asked to identify economic benefits associated with dams. These concepts were drawn from V. Energy Resources and Consumption and E. Hydroelectric Power in the topic outline.

Students were then asked to demonstrate knowledge of an ecological benefit of seasonal flooding of the floodplain of a free-flowing river. Students were next asked to explain the benefits to fish populations associated with removing a dam from a river. Students were next asked to describe one negative environmental consequence of removing a dam. These concepts were drawn from I. Earth Systems and Concepts C. Global Water Resources and Use of the topic outline. Students were then asked to demonstrate their understanding of keystone species. Students were asked to define a keystone species and to describe how dams built by beavers in some ecosystems make the beaver an example of a keystone species. These concepts were drawn from the II. The Living World, subtopic A. Ecosystem Structure in the topic outline.

Sample: 4A

Score: 10

The student earned 3 points in part (a) for explaining how electricity is generated at a hydroelectric dam: 1 point for “water is allowed to flow,” 1 point for “water turns a turbine,” and 1 point for explaining that the turbine “runs an electric generator, thus producing electricity.” The student earned 2 points in part (b) for identifying economic benefits associated with dams: 1 point for “recreational activity” and 1 point for job creation from dam construction. The student earned 1 point in part (c) for describing how seasonal flooding “provides nutrients from the river to the floodplain thus creating fertile soil.” The student earned 1 point in (d)(i) for explaining that the removal of a dam can benefit fish populations because fish can now “swim down stream unblocked by the dam thus opening up new niches.” The student earned 1 point in (d)(ii) for describing that the “buildup of all the toxic chemicals and pollutants” accumulate behind the dam. The “re-releasement of pollutants into the environment” occurs after the dam is removed. The student earned 2 points in part (e): 1 point in (e)(i) for defining a keystone species as a species that “stabilizes the ecosystem” and 1 point in (e)(ii) for the description that dams “change the course and function of the river, actually making it inhabitable for many species,” which explains how beavers can be keystone species in some ecosystems.

Sample: 4B

Score: 8

The student earned 2 points in part (a) for explaining how electricity is generated at a hydroelectric dam: 1 point for “water passes” and 1 point for water “turns a turbine.” No point was earned for “creates electricity” since the mechanism of electricity generation is not explained. The student earned 2 points in part (b) for identifying economic benefits associated with dams: 1 point for the “creation of jobs to build” the dam, and 1 point for “recreational activity.” The student earned 1 point in part (c) for the description of flooding creating “seasonal pools” that “provide breeding and nursery habitats.” The student earned 2 points in part (d): 1 point in (d)(i) for explaining that the dam removal allows “anadromous species to go upstream to spawn” and 1 point in (d)(ii) for describing that the removal of the dam can “create rapid flows which can washout banks and structures down stream [sic],” which can harm organisms. The student earned 1 point in (e)(ii) for describing that beavers building dams can “create ponds which provide habitat for numerous species.”

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Question 4 (continued)

Sample: 4C

Score: 6

The student earned 2 points in part (a) for explaining how electricity is generated at a hydroelectric dam: 1 point for “water in a reservoir flows” and 1 point for “turns turbines.” The student earned 1 point in part (b) for identifying that one economic benefit associated with a dam is “tourist attractions.” The student earned 1 point in part (c) for describing that “nutrient-rich sediment [*sic*] gets deposited” following seasonal flooding. The student earned 1 point in (d)(i) for explaining that following the removal of a dam “salmon carry out their natural migration upstream.” The response earned 1 point in (e)(i) for indicating that a keystone species contributes to “stability of the environment.”