Chief Reader Report on Student Responses:

2017 AP® Environmental Science Free-Response Questions

- Number of Students Scored 159,578
- Number of Readers 406
- Score Distribution

Exam Score	N	%At
5	15,090	9.5
4	39,129	24.5
3	24,591	15.4
2	39,036	24.5
1	41,732	26.2

- Global Mean 2.67

The following comments on the 2017 free-response questions for AP® Environmental Science were written by the Chief Reader, Alan McIntosh. They give an overview of each free-response question and of how students performed on the question, including typical student errors. General comments regarding the skills and content that students frequently have the most problems with are included. Some suggestions for improving student preparation in these areas are also provided. Teachers are encouraged to attend a College Board workshop to learn strategies for improving student performance in specific areas.

Question #1

Task: Document-Based Question
Topic: Water Pollution/Water Treatment
Max. Points: 10
Mean Score: 4.95

What were responses expected to demonstrate in their response to this question?

This question was intended to have students describe the impact of various pollutants on aquatic organisms and on water quality, to identify and describe common methods of sewage (wastewater) treatment, and to demonstrate an understanding of the importance of mangrove swamps, an example of an ecosystem threatened by human activities. Students were asked to read the document provided and describe the impacts of ingesting microbeads on aquatic organisms. This concept was drawn from VI. Pollution, B. Impacts on the Environment and Human Health, 2. Hazardous Chemicals in the Environment of the topic outline. Students were then asked to describe how nitrates, a different water pollutant, can negatively affect water quality in some aquatic ecosystems.

The next part of the question evaluated student understanding of wastewater treatment. Students were asked to identify one way large objects, such as plastic, could be removed during primary wastewater treatment and to then identify one common technique to disinfect wastewater prior to discharge. Additionally, students were asked to identify one advantage and one disadvantage of spreading biosolids (sludge) on agricultural fields. These concepts were drawn from VI. Pollution, subtopic A. Pollution Types, section 3. Water Pollution of the topic outline.

Students were then asked to demonstrate their knowledge of the importance of ecosystem diversity and the threat of human activities to ecosystems using the mangrove forest as an example of a threatened coastal ecosystem. Students were asked to provide a reason as to why humans remove mangrove tress and to identify an ecosystem service provided by intact mangrove forests. These concepts were drawn from
II. The Living World, subtopic C. Ecosystem Diversity of the topic outline.

How well did the responses address the course content related to this question? How well did the responses integrate the skills required on this question?

Question 1 required students to apply several course content components within the context of reading and evaluating an article on microbeads and aquatic pollution. Specifically, students were expected to be knowledgeable about the impact of pollutants on aquatic ecosystems, the steps in wastewater treatment, and human impacts on mangrove ecosystems.

- The majority of students were able to extract information from the document to answer the question about an effect of microbeads on aquatic organisms in (a). A correct response described how organisms' digestive tracts were blocked by microbeads. Students who stated that PCBs and dioxins were harmful to individual organisms did not demonstrate an understanding of bioaccumulation and/or that these substances are toxic and fat soluble. Conflating "biomagnification" with "bioaccumulation" was a common misconception. Many responses used these two terms interchangeably, or misused "biomagnification" for the other term. A clear understanding that bioaccumulation is a process that occurs at the organismal level, whereas biomagnification is a process that occurs at a larger scale (in a food chain or food web) is an important distinction.
- Many students were able to correctly describe an algal bloom as a consequence of increased levels of nitrates. Many students correctly discussed the cascade of effects that occur as a result of cultural eutrophication. One common misconception is that nitrates are a direct cause of low dissolved oxygen levels (hypoxia) in bodies of water. Another misconception is that the algae are consuming the oxygen rather than the decomposers which are using cellular respiration to break down dead algae. Knowing the intermediate steps in the correct order is a key understanding for water quality. Many students demonstrated that they understood the impact of cultural eutrophication on dissolved oxygen by linking the change in oxygen level to increased cellular respiration in decomposers.
- Many responses earned points for identifying two steps in wastewater treatment, the physical screening of large plastics and the use of a disinfection technique such as chlorination or ozonation. Some students incorrectly claimed that "heating" or "boiling" wastewater could be utilized for disinfection at the municipal level.

- Many responses earned a point for identifying an advantage of spreading biosolids (sludge) on agricultural fields. Frequent correct responses included the addition of nutrients to soils, increased crop yields, and the reduced need for other methods of disposal, such as placing biosolids into a landfill. More students were able to identify advantages of spreading biosolids than disadvantages.
- Many responses earned a point for correctly identifying a reason that humans remove mangroves; for coastal development, production of wood products, and availability of additional land for agriculture. Many responses earned a point for correctly identifying one ecosystem service provided by the intact mangrove ecosystems. Frequent correct responses included shoreline stability, maintaining or increasing biodiversity and flood control. A misconception was that "ecosystem services" is synonymous with "ecosystem function." Some responses described an ecosystem function, such as providing habitat, but did not clearly demonstrate how that function provided a benefit to humans.
- With the exception of the question in part (a) regarding the effects of ingesting microbeads on organisms, students were able to correctly read and interpret the questions.

What common student misconceptions or gaps in knowledge were seen in the responses to this question?

Common Misconceptions/Knowledge Gaps	*Responses that Demonstrate Understanding*
• Nitrates or algae directly cause a drop in dissolved oxygen levels	• "When nitrate levels are high, more algae can bloom because nitrogen is a limiting factor. When the surplus algae dies, oxygen is extracted from the water so decomposition may occur. This dramatically reduces D.O. (dissolved oxygen) levels, which can cause organisms to suffocate and die."
• Bioaccumulation and biomagnification can be used interchangeably	• "Another effect that microbeads have on organisms is the bioaccumulation of pollutants such as PCBs and dioxin. The microbeads can absorb these pollutants, since the organisms digest the microbeads the pollutants ultimately end up in their system." • "It also accumulates organic pollutants in the organism's system."
• Ecosystem services are mistakenly identified as ecosystem functions	• "They offer an opportunity for fishing and other recreational activities." • "Provide homes for animals that could be a source of food for humans."

Based on your experience at the AP® Reading with student responses, what advice would you offer to teachers to help them improve the student performance on the exam?

- Students should be reminded to carefully read the questions. A common mistake was to describe the effect of organic pollutants on food chains; however, the question asked for the effects of ingesting microbeads on organisms.
- Students need to use specific examples in their responses. Responses in which the meaning of a term is vague or not clearly conveyed may not earn the point(s).
- Students should practice writing responses that use vocabulary correctly. They should be encouraged to avoid general terms such as "harm," "destroy," "change," and "pollute" unless they qualify what is being impacted, how the impact is occurring, and/or the direction of the impact.
- When teaching about bioaccumulation and biomagnification, it is useful to emphasize that the bioaccumulation occurs at the level of individual organism, whereas biomagnification is at the food chain/web level. Bioaccumulation can result in biomagnification. A useful tool for biomagnification is the use of an upside down trophic pyramid. At each level the concentration of toxin accumulated can be listed on the diagram to help students distinguish between the two.
- A beginning approach to teaching cultural eutrophication is to have students write or diagram the steps numerically (some textbooks do this). A deeper understanding can be gained by integrating concepts from population biology. Including a description/explanation of the eutrophication process (e.g. drawing a population growth curve for the algae ("boom-bust") and annotating with the addition of nitrates), the increased population growth of decomposers, and levels of oxygen expected to occur during the process may help students better understand the intermediate steps between the beginning of the algal bloom and the end result of decreased concentrations of dissolved oxygen.
- "Ecosystem services" is an important concept that was developed in the late 1990s. Ecosystem services are the natural processes which benefit people either directly or indirectly. There are many resources available on the internet that describe ecosystem services, such as the US EPA's website. A seminal article by Costanza et al. (1997) is readily available on the internet. Although some of the content may be beyond the scope of the course, the abstract and tables could be utilized as a reading assignment.

What resources would you recommend to teachers to better prepare their students for the content and skill(s) required on this question?

Teachers of AP Environmental Science can find useful resources in the Course Audit webpage and AP Central Home Page for AP Environmental Science. The following curriculum modules will provide additional information on these concepts: 1. Ecology, 2. Energy Climate & Change.

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Question #2

Task: Graph Creation/Calculations

Topic: Loss of Biodiversity

Max. Points: 10

Mean Score: 4.73

What were responses expected to demonstrate in their response to this question?

This question was intended to have students analyze a data table of the estimated population size of elephants on the African continent. Additionally, students were asked to explain how reproductive strategies could lead to the extinction of a species and how conservation strategies could be implemented to prevent the extinction of a species.

Students were asked to correctly plot the data in the table on the axes provided, with the direction that the independent variable be placed on the x-axis. Students were then asked to use the data in the table to calculate the percent loss of elephants in Africa from 1970 to 2000 and to calculate (predict) the size of the African elephant herd in 2022, based on a 20 percent decline in the herd size from 2015 to 2022. These concepts were associated with science practices 5.1 – 5.3 (The student can perform data analysis and evaluation of evidence) for the graphing task and science practices 2.1 – 2.1 (The student can use mathematics appropriately) for the calculations.

In the next part of the question, students were asked to demonstrate their knowledge of reproductive and conservation strategies in large mammals prone to extinction. Students were asked to identify a characteristic of a K-strategist and explain how that characteristic could make the species prone to extinction. In the final part of the question, students were asked to identify and discuss two conservation strategies that could be implemented to prevent the extinction of large terrestrial mammals. These concepts were drawn from III. Population, A. Population Biology Concepts and VII. Global Change, subtopic C. Loss of Biodiversity in the topic outline.

How well did the responses address the course content related to this question? How well did the responses integrate the skills required on this question?

Question 2 required a student to apply several course content components within the context of data analysis and data presentation focused on population dynamics in large terrestrial mammals. Students were expected to perform simple calculations without the aid of a calculator, to properly graph a data-set, and to be knowledgeable about the population dynamics of large, terrestrial mammals and their interactions with human beings.

- In part (a) of this question, student responses were often well-crafted graphs with properly scaled and labeled axes and properly placed data points.
- In part (b), students calculated the percent loss of elephants in Africa between 1970 and 2000 using various methods. Most responses followed the difference divided by the initial value method that typically led to a correct answer. Some responses demonstrated other methods such as dividing the initial value by the final value to yield a fraction that was then added numerous times to yield the difference and then converted into a percent loss. In part (c), student responses largely followed the methods shown on the rubric.
- Many student responses in (d) demonstrated an understanding of the characteristics of a K-strategist species and how these characteristics may make these large, terrestrial mammals prone to extinction. The most common characteristic, by far, was that K-strategists produce few offspring. Student responses then often connected this characteristic and other correct answers to either difficulty in recovering from a population decline or difficulty in adapting to changing environmental conditions.
- Next, many student responses for part (e) properly identified an extinction-preventing strategy that could be implemented. In order for students to earn a point for a strategy, they needed to discuss how the strategy could be implemented. Some students presented a goal for recovery, rather than a realistic strategy. Many student responses included the detail and directness necessary to earn these two points.

What common student misconceptions or gaps in knowledge were seen in the responses to this question?

Common Misconceptions/Knowledge Gaps	*Responses that Demonstrate Understanding*
• Students constructed a graph with an inconsistent number of grid blocks between years presented in the data.	• Grid axes are scaled with consistent increments and properly labeled axes. Data points are plotted correctly.
• Students incorrectly calculated the percent difference.	• $\frac{2{,}000{,}000 - 400{,}000}{2{,}000{,}000} = 0.8 \times 100 = 80\%$
• Students miscalculated the percent of the elephants remaining in Africa in 2022.	• $1 - 0.2 = 0.8$ $\quad 600{,}000 \times 0.8 = 480{,}000$
• Students equated small populations with threatened populations.	• "when a portion of them is killed off, it is much more difficult for the species to recover back to its initial population … because its reproduction rates are so low."
• Students failed to discuss how the desired strategy could be implemented to prevent extinction.	• "Habitat protection can be done with a national park or reserve that allows mammals to live in peace and reproduce."

Based on your experience at the AP® Reading with student responses, what advice would you offer to teachers to help them improve the student performance on the exam?

- Students should create graphs by hand from various environmental data sets.
- Students should routinely apply simple mathematical methods to various environmental data sets showing all work. Students should practice completing simple calculations without a calculator and evaluate the units and scales for accuracy.
- Students should be familiar with different life-history strategies. Some students misidentified a K-strategist species with a specialist species. K-strategy is a reproductive strategy, while specialists gain their nutrition from the environment from very few sources. It is important for students to be able to understand various characteristics of different species and make comparisons.
- Students should examine examples and causes of extinction in different regions of the world. Students should evaluate different strategies and solutions to combat/negate the threat of extinction.

What resources would you recommend to teachers to better prepare their students for the content and skill(s) required on this question?

Teachers of AP Environmental Science can find useful resources in the Course Audit webpage and AP Central Home Page for AP Environmental Science. The following curriculum modules will provide additional information on these concepts: 1. Ecology, 2. Energy Climate & Change.

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Question #3

Task: Synthesis & Evaluation
Max. Points: 10
Topic: Deforestation and Population Dynamics
Mean Score: 4.92

What were responses expected to demonstrate in their response to this question?

The question was intended to measure students' knowledge of the impacts of deforestation in less developed countries. Students were asked to explain why deforestation commonly occurs in less developed countries and to describe a realistic strategy to reduce deforestation in these areas. These concepts were drawn from IV. Land and Water Use, subtopics A. through D. and III. Populations, subtopics A. Population Biology Concepts and B. Human Populations. Students were then asked to identify one change in stream water quality that can occur in a deforested watershed and to explain how deforestation caused the identified change. These concepts were drawn from I. Earth Systems and Resources, subtopics C. Global Water Resources and Use, and D. Soil and Soil Dynamics of the topic outline. The students were next asked to demonstrate knowledge of additional environmental benefits for maintaining forest ecosystems, not related to water quality. These were drawn from III. The Living World, subtopics A. through E. in the topic outline.

In the second part of the question, the stimulus provided demographic data for Haiti for 1995 and 2015 that was used to assess the students' knowledge of factors that could affect life expectancy and fertility rates. Students had to analyze the data in the table and identify and discuss one factor that contributed significantly to the change in life expectancy. The students then had to analyze the data in the table, with respect to fertility rates, and to identify and discuss one cultural or economic factor that could contribute significantly to the change in fertility rate. These concepts were drawn from II. The Living World C. Ecosystem Diversity and III. Population, subtopics A. Population Biology Concepts and B. Human Population.

How well did the responses address the course content related to this question? How well did the responses integrate the skills required on this question?

Question 3 required a student to apply several course content components within the context of a scenario focused on less developed countries. Specifically, students were expected to be knowledgeable about the causes and effects of deforestation and about realistic strategies to reduce deforestation. They also had to identify and discuss factors that could lead to increased life expectancy and decreased total fertility rates in a less developed country like Haiti.

- In general, students understood the specific causes of deforestation in less developed countries. Responses clearly indicated that less developed countries use trees/wood as a readily available and economically viable resource for heating homes, cooking food, and building shelters. Many responses also indicated an understanding that less developed countries may have fewer laws that protect their forests, which can lead to deforestation. Many students were able to describe a realistic strategy for reducing deforestation such as strengthening environmental regulations to protect the forests, establishing sustainable agriculture programs, using higher crop yield varieties, or applying fertilizer to increase yields.
- Students demonstrated an understanding of the impact of deforestation on stream water quality. Though the descriptions varied (increase in silt, sediment, soil particles, turbidity, etc.), many students demonstrated that they understood the role of tree roots in maintaining soil quantity and reducing soil erosion. Students clearly explained how tree canopy removal from deforestation could lead to an increase in stream temperature by increasing the amount of sunlight reaching the water's surface.
- Most students identified an aspect of habitat protection as an environmental benefit of maintaining forest ecosystems, and many also tied biodiversity to their discussion of habitat. A response that included both habitat and biodiversity as an environmental benefit received only one point due to the linkage between habitat and increasing biodiversity. Many students identified forests as carbon sinks or providers of oxygen for organisms to use as additional environmental benefits.
- The final two components of Question 3 required students to analyze a table that contained three demographic measures comparing 1995 and 2015 data for Haiti. Many students were able to accurately describe the directional change in these measures over the 20-year period (increase in life expectancy and decrease in fertility rate). Most students identified the increase in life expectancy as a result of increased access to health care and then continued with a discussion of how increased access to health care impacted

life expectancy. Most students identified either increased education for women or more job opportunities for women as factors that decreased the fertility rate. Students discussed how, with increased economic or educational opportunities, women will have fewer children because of delayed age of marriage/first reproduction, more options for birth control, or increased decision-making opportunities.

- Many students who did not earn points had inaccurate responses, not because they did not present enough detail or depth in their answers. Most students were able to accurately read the demographic data table and demonstrate the required directionality (increase in life expectancy, decrease in fertility rate) in order to earn the most points.

What common student misconceptions or gaps in knowledge were seen in the responses to this question?

Common Misconceptions/Knowledge Gaps	*Responses that Demonstrate Understanding*
• People in less developed countries cut down the trees because they are not educated about the impacts of deforestation	• "Deforestation commonly occurs in less developed countries such as Haiti because widespread poverty moves people toward deforestation and using wood as a source of biofuel."
• Students tied dissolved oxygen in freshwater streams to oxygen production from trees. Students claimed that the decrease in dissolved oxygen resulted from the trees putting less oxygen into the water	• "The dissolved oxygen content in streams can decrease due to deforestation. Cooler water is able to hold more dissolved oxygen. When trees, providing shade from the sunlight in the stream, are cut down, they expose the stream to more direct sunlight, increasing its temperature and therefore decreasing the amount of dissolved oxygen in it."
• Economic benefits are the same as environmental benefits	• "Maintaining forests allows for greater biodiversity. The trees allow for various organisms to thrive which cannot happen if a forest has been clear-cut."

Based on your experience at the AP® Reading with student responses, what advice would you offer to teachers to help them improve the student performance on the exam?

- Students should be reminded that when a question asks for one reason or factor, only the first reason or factor given will be scored. Students should choose their strongest answer and make that the focus of their discussion. Listing additional factors are not an effective use of the student's time.
- Students should be sensitive to cultural differences among various regions of the world. Often, traditional environmental knowledge is extensive and effective for a sustainable society. Indicating that citizens of countries other than their own are "uneducated," "uninformed," or "not knowledgeable" about the environment are not effective ways to describe groups of people. There may be other social/cultural/economic factors driving behaviors in less developed countries.
- When asked to discuss a change in a scenario (either using data or a situation), students must indicate the directionality of that change. Words like 'increased' or 'decreased' should be used within their response as opposed to using 'change,' which could be too vague to address the question.

- Students should make sure they can differentiate between climate change and ozone depletion. Some students discussed an increased in atmospheric carbon dioxide as a factor in ozone depletion. This is a common misconception, and students should be clear that these are two separate global phenomena.
- Some students misunderstood the concept of a watershed. These students thought the stream itself was the watershed as opposed to the deforested catchment or drainage basin.

What resources would you recommend to teachers to better prepare their students for the content and skill(s) required on this question?

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Question #4

Task: Synthesis & Evaluation
Max. Points: 10
Topic: Hydroelectric Power/Keystone Species
Mean Score: 4.31

What were responses expected to demonstrate in their response to this question?

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 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, subtopic 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.

How well did the responses address the course content related to this question? How well did the responses integrate the skills required on this question?

Question 4 required students to apply several course content components within the context of hydroelectric power and removal of a dam on a river. Specifically, students were expected to be knowledgeable about hydropower generation of electricity, the ecological and environmental effects of human-made dams, free-flowing rivers as a water resource both under pre-dam conditions and in the context of a dam removal, and the definition of keystone species and the role of beavers as a keystone species in an aquatic ecosystem.

- The majority of students were able to identify at least two of the three steps in hydroelectric power generation in (a). Most were able to recognize the movement of water through the dam and that the water spun turbines. Simply indicating that the turbine "moved" was not adequate, since it did not demonstrate that students understood the mechanics of the turbine. If students missed a point in the hydropower section, it was typically the last step involving the generator. Students often omitted the generator step and indicated that electricity was generated directly by the turbine or that the generator simply stored energy produced by the turbine. Some students confused hydropower with other forms of energy production and included an extra step of converting the water to steam through a variety of mechanisms. While less common, a number of students indicated that friction was directly converted to electricity rather than properly understanding that friction would reduce the efficiency of energy conversion.
- Most students were able to identify at least one economic benefit associated with dams. Students who did not get both points in (b) usually identified two different examples of the same concept or discussed benefits of hydropower in comparison to another form of energy production. Although no point was awarded because hydropower energy generation was mentioned in their responses, some students indicated that, other than the capital cost of constructing the dam, hydropower would be a free energy resource.
- Students were able to correctly identify several benefits of seasonal flooding in part (c). Nutrient deposition increasing soil fertility was particularly common, but many students also recognized the benefits of seed deposition, aquifer recharge, and habitat creation. Students who did not recognize that seasonal flooding is naturally occurring and that riparian ecosystems are typically adapted to those events did not answer this question correctly. Similarly, most students provided acceptable answers regarding the negative environmental consequence of removing a dam, with descriptions of habitat loss and the release of accumulated sediment or pollutants the most common. While describing a destructive flood from a sudden dam removal received a point, some students did not recognize that flooding itself was not necessarily an ecologically negative consequence. Some students incorrectly indicated that the energy from tidal changes or waves could be captured and converted to electricity.

- Students who received a point for defining a keystone species were able to demonstrate an understanding that such species play an outsized role relative to their abundance or that they have a strong effect on ecosystem "stability." Students who did not earn the point typically confused the keystone species concept with a multitude of other concepts, including apex predators, pioneer species, indicator species, or predator/prey and trophic cascade models. Students who earned the point in (e)(ii) for describing how beaver dams make beavers a keystone species typically described habitat alteration or the reduction of floods, water-borne pollutants, or downstream erosion. Students who did not receive the point often simply rephrased their definition of keystone species or failed to give an explanation of how the environmental alteration affected other species in the ecosystem.

What common student misconceptions or gaps in knowledge were seen in the responses to this question?

Common Misconceptions/Knowledge Gaps	*Responses that Demonstrate Understanding*
• Electricity is generated by spinning turbines without any apparent connection to a generator.	• "…a turbine is spun from the motion of the water. The turbine is connected to a generator to create electricity from the spinning motion."
• All types of floods, including natural seasonal flooding, are ecologically destructive.	• Seasonal flooding "provides nutrients from the river to the floodplain thus creating fertile soil that many plant organisms thrive in…"
• Ecological terms such as indicator species, top-carnivore, or k-selected are interchangeable.	• "A keystone species is a species which has a disproportionate (to its number of individuals) effect on its ecosystem without which the ecosystem would not be able to function properly or even survive."

Based on your experience at the AP® Reading with student responses, what advice would you offer to teachers to help them improve the student performance on the exam?

- Students should understand species concepts and speciation mechanisms. Misunderstandings about mechanisms to increase biodiversity indicate that students need clarification regarding the basic principles of evolution.
- When discussing power generation, it is important to emphasize that methods vary. Many students tried to incorporate steam generation into the steps involved in hydroelectric power generation. The strongest responses recognized that the reservoir behind that dam provided potential energy that could be converted to kinetic energy in the penstock without requiring the input of energy from fossil fuels.
- When possible, incorporate examples of different species in different regions into presentations. Students should be able to evaluate environmental problems from different regions of the world.
- Students should be able to differentiate between economic, ecological, and environmental benefits. For example, discussing agriculture as an "ecological benefit" would not earn a point.
- Students should take the time to read the questions carefully. While all parts of the question were inter-related, some students did not keep track of whether a section was referring to human-made dams or beaver dams or whether the section was referring to conditions when the dam was present or when the dam was absent. Some students also referred to power generation in part (b), even though the stem of the question specifically stated "other than hydroelectric power generation."

- Remind students to provide meaningful terms and complete descriptions. Describing the relative importance of a keystone species within an ecosystem is a more thorough answer than simply stating that it is "important" or "critical" with no further description.
- Students should be comfortable correctly using scientific terms and definitions. Some students used the term "keystone species" synonymously with apex predator, indicator species, pioneer species, and even various models of trophic structure and trophic cascades. Students who misused terminology in their responses did not earn the point.

What resources would you recommend to teachers to better prepare their students for the content and skill(s) required on this question?

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