Ecology -- Hammond Coaches Clinic 2006

Prepared by Tom Wellnitz, The Paideia School, Atlanta, Georgia
wellnitz.tom@paideiaschool.org

What is the event? -- See the rule sheet. The event covers a wide subject area. Students will need to be aware of a great level of basic information. Questions should emphasize applications, but you will likely see many questions that test understanding of vocabulary.

What will your students see? Who knows. The percentage rules actually get tighter as you head towards nationals, which means regional events could be about anything. Equally troubling is that with two different ecosystems, there is nothing that says each should be covered equally. One event might emphasize forests and another marine. (Perhaps one of your oceanography students should be one of the ecology students?)

Event allows stations. There is no advantage to stations here because almost everything you will get should be a paper exercise; no ecological studies can be brought in or done in the amount of time available! However, you might alert your students what to do with stations. Two quick things to remember for stations: Split up the questions and move quickly between stations, taking all your belongings with you.

How to prepare? Find a basic ecology text -- most AP biology books probably have good sections. Unlike some SO events (e.g. Astronomy) I don't think the college level ecology texts are the best resources. Too many of their examples are mathematical, and the calculus level of ecology should be beyond Div. C SO. Often introductory books have enough on the basic ideas and may be the best places to find simple glossaries. Students should be familiar with the ideas covered in the rules. Other background topics involve some genetics and the principles of evolution; you could see these because ecology often involves these. There are a number of books about biomes or specific biomes that you might find in an elementary age library.

For Division B teams, many middle school books would be okay but I'd also have students look over the ecology sections in an introductory high school biology text. Often the introductory level isn't much different from what students saw in middle school. Then pick topics in line with what is included on the Div . B rules; I would stretch beyond them because the

college people who run events may include what they think are basic ideas but typically aren't covered in middle school. Some of my handout is too advanced for middle school kids. (I included some things from my college ecology text, and I don't remember what some of the diagrams mean, see especially pages H-17 and H-20**.**)

Go over graph reading (use paper edge to get straight edge) and experimental design and interpretation. Examples of good questions from graphs: find actual values, rate of change, possible causes of changes,which organism would you predict to do better if something changes. Students should be familiar with arithmetic and logarithmic scales (see page H-20 for example) . Much of this packet contains examples of questions that emphasize problem solving skills; see especially pages H -- 22 through H-34..

What to take in? If you can take in resources (but you probably can't), one should be a glossary of related terms. Sometimes one person calls something by one term, another by a similar phrase. A calculator is a must, although if you need to use it much, you probably will have an event in which the event supervisor put in a great deal of time. (If you have enough, send in 2 calculators so students can be working on different sections.)

Basic Ecology notes:

Ecology involves interactions -- between organisms, between organisms and their environment, between different species. Some of the interactions have special names like predator/prey or the "isms" (e.g. mutalism) listed on the rule sheets. There are probably as many as 30 (maybe more) terms your students just have to know. Start with the rules, then check out the terms mentioned in an intro biology or even a middle school text.

Important cycles: water, carbon/oxygen, nitrogen, phosphorus (especially important for marine) other important nutrients. Special note: some nutrient cycles work differently in the water than on the land. See examples later in the packet.

Biomes: influenced by amount of light, temperature, water, and to a lesser degree type of soil present.

Food webs: Start with producers (usually a plant or in water some type of plankton). Plants are producers, do photosynthesis (students should have understanding of what happens in photosynthesis because any of the factors could become limiting). Food web is the preferred name; food chains are single paths within web. Producers capture sunlight; consumers eat other things. Herbivores are primary consumer. Typically most biomass in the total mass of producers. Rule of thumb is only 10% of energy available at next level -- many fluctuations in real world 1-20% for example. Energy is often confused with biomass.

Carrying Capacity -- number of organisms environment can support. Often don't know population is at carrying capacity until numbers exceed it. Capacity can change depending on limiting factors.

Population studies can be done with all size organisms. I particularly like the use of human population examples.

Niche -- many factors including food source, how food obtained (e.g. beak size), time of day when active, height, sun preference, attraction to other predators, ability to withstand loss of resource, when and how of reproduction

Reproduction -- affected by number of organisms present, ability to find mate, adequate food supply, habitat where reproduction takes place, weather conditions, health of parent, estrus cycles, number of offspring, gestation periods.

Succession -- refers to order in which organisms show up in an area. At all levels, succession is about adaptation and ability to use the nutrients and environmental conditions present.

Primary succession refers to the process by which organism make soil or colonize an area without much or any life. Lichen on rock is primary succession. To go back to the general idea, lichen are able to survive on the barren rock. Later, other organisms can live in the soil, which is most detritus.

Secondary succession is order in which plants fill in an area which already has soil. There is the lake to bog to grassland to forest sequence; each plant type is able to grow in the existing conditions. Another one is seen with some forests. Early forests have trees that need lots of light in order to

germinate. These grow and eventually produce so much shade that young plants of the same type can't grow. Then a new type of tree starts to grow, one which can grow in limited light condition. Usually this tree type is given the name climax forest because if conditions don't change, this tree type remains. However, most forests are affected by fire, insects, wind, drought,or disease eventually so climax forests may change over time,allowing other light needing trees to reappear.

Abiotic factors -- the non-living aspects of the environment. Examples: temperature, water, sunlight, soil conditions. Often the extremes are more important than the median or mean; only takes one cold day to kill off some organisms. For other factors, the average may be more important than the whole. For example, when does rain come? Atlanta may get lots of rain in a year, but can have severe drought effects if no rain in summer.

Water -- a special abiotic factor. Students should be familiar with many of the special properties of water. High heat capacity, pH, polarity, ability to dissolve or suspend many substances, density change between $4^{o}C$ and $0^{o}C$, surface tension, three states within narrow temperature range, energy needed to convert ice to water and water to steam.

Then with marine environments, you also need to be aware of salinity, the fact that salt water doesn't freeze at $0^{o}C$, salt becomes more concentrated as water freezes, pressure, and what happens to light as it passes through water. While on the subject of water, physical features of the ocean -- tides and currents -- especially have important influences on living organisms.

Animal behavior can overlap ecology so students might want to pay attention especially to some mating behaviors and migratory factors.

When I've taught ecology, comparing the examples in the book to **human systems** can be very interesting. For example, compare the carbon cycle of a forest to that of a city. Seeing how humans are trying to live outside the rules that apply to other organisms can be one of the most useful things for students to learn.

Comments on this year's featured ecosystems

Forests: Although the rules suggest that each year there will be a different biome, forests actually cover three main biomes (and more if you have finer subdivisions). These are Tropical Rain Forests, Temperate Forests, and Boreal Forests also called Taiga or Northern Coniferous Forests. Among the smaller categories you might want to have your students be familiar with are Chaparral, temperate rain forests, and deciduous rain forests. You should know how forests are affected by mountains.

Forests are distinguished by their trees. The other remaining biomes are grasslands, deserts, and tundra which lack tress. All things being equal, more annual precipitation is needed to support trees. Type of trees are influenced by temperature. Tropical rain forests are often evergreen (often broad leaf), temperate forests deciduous (often broad leaf), and taiga is dominated by evergreens (conifers -- pines, firs, and spruces).

Students should know what other organisms -- particularly plants and animals -- are typically found in each of the forest types. They should be able to recognize these biomes (and all others) from a climatograph (shows typical temperature and precipitation, see example on page H-2. Students should be aware how climate conditions affect organism interactions: In taiga, cold is very important; freezing temperatures control many insect pests, conifers do well because their needles survive all winter (photosynthesis takes place sooner as temperatures warm, needles not damaged by late spring frosts). Broadleaf varieties do better without the cold, probably because surface area of leaves allow more photosynthesis to take place. In tropics, many plants defend themselves with chemicals because temperature not enough to kill insects.

For some forests, fire is an important factor to consider. Some conifers (e.g. Jack Pine, Giant Sequoia) won't open cones without fire. So a fire allows new growth to occur. In SE US, Longleaf pine dominates areas where fire is allowed because the first few years of growth, tree has a grass stage where it remains very short and grows an extensive root system. It survives fires where the broad leaf trees don't. Without fire, broadleaf dominates because it quickly shades the pines.

Tropical forest factoid: Tropical soil deteriorates rapidly (loses nutrients

within a few years) when clear cut and exposed to sun. Hard to regenerate forest if left exposed. Contemporary humans often "slash and burn" areas. Result frequently is short term gain in fertility then loss of soil. New evidence suggests that native populations (pre Columbian) managed South American Tropical Rain Forests by planting many of the productive tree crops. They also did "slash and char" tilling in the charcoal to the soil, which made the soil better.

Students should be aware how human interactions can affect forests. Examples: Global warming might make conditions too warm for primary trees to survive in current location. Trees can't migrate so they could die off. Some areas might be affected by change in precipitation -- less or more, less snow pack. Many animals depend on heavy snow pack to keep from freezing during the winter. Acid rain effects worse in areas with granite bedrock than in areas with limestone; midwest (e.g. Indiana, Ohio, Michigan) has limestone soil whereas New England more granitic. Air pollution has effect on trees too. Sometimes the effects are to weaken the trees which then allows insects to succeed.

Note about elevation effects. Higher elevations are colder, so you might see tree types that exist more towards poles (more northern in most of the world -- forests not common in southern hemisphere.) Also, direction of hillside is important. South facing (again northern hemisphere) sides are warmer, get more sun, and lose snow cover faster.

Forests and food webs: Most food webs you see depend on consumers eating nearly all the producer. In forests, most of the trees after a certain age are not eaten. Much of the food or energy from the trees is from their seeds -- acorns, nuts, pine cones. Those that "eat" the bulk of the tree mass -- insects primarily often don't get mentioned in a food web.

Marine: This is another expansive area. With over 2/3 of the Earth's area, the ocean offers many different types of ecosystems. Here are some different areas your students should consider: tidal pools and littoral zones, coral reefs, salt marshes, estuaries (river and ocean meeting), shallow water (e.g. can plants anchor and still get light), epipelagic or euphotic zone (depths at which photosynthesis can take place because sunlight can penetrate only so far -- usually fewer than 200 meters), deep ocean, ocean bottom, and hydrothermal vents. There are more animal species on land (largely because insects don't live in the ocean). Many food webs include high level (4, 5 or

higher) consumers as fish eat fish; biggest animals are low order consumers -- almost "herbivores."

Limiting factors determine what lives where. Some important factors: availability of light (depth of water and latitude), salinity, water temperature, depth creates pressure and some organisms can't leave where they are adapted to high pressures, availability of nutrients --especially phosphorus (more common along coasts and in areas of upwelling), for littoral areas -- number of hours when exposed to air. Consequences of these factors: most sea life lives in shallow water near the surface. Another interesting tidbit concerns extinction of organisms at the K-T boundary (dinosaur extinction). More species of tropical plankton went extinct than species that live in polar areas; one hypothesis is that extinction came about from loss of sunlight and polar organisms were used to not having light for part of the year so they survived because they acted like it was winter.

Students need to be aware of the special features of life in the hydrothermal vents. The tube worms, clams, and shrimp that live there depend on bacteria that chemosynthesize (not photosynthesize). These bacteria use H_2S in an analogous way to how water is used in photosynthesis. At the basic level, students need to know that not all live depends on the sun.

Students should understand how the abiotic factors of the ocean affect organisms. For example, students should understand why upwelling of nutrients occurs, not just that is common on the west coast of North and South America. If I were running the event at a competitive level, especially with high school students, I'd give students a map of "Earth" at another period of time. Continents would not be in same position. Students would be asked to determine where they would expect to find areas of greatest productivity.

Resources:

General Reference: Gonick, Larry and Alice Outwater *The Cartoon Guide to the Environment,* Harper Perennial, 1996. ISBN 0-06-273274-9. Students might like it because it has lots of drawings and humor throughout. It covers basic ideas and has good information about human

effects. See page H -34 example of what is there.

One reference that covers physical and biological aspects of the ocean is Parker, Henry S., *Exploring the Oceans: An Introduction for the Traveler and Amateur Naturalist* Publisher**:** Prentice Hall (January 1987) ISBN**:** 0132977141

Internet resources: (By no means an exhaustive list)

S Olympiad ecology references: http://www.soinc.org/events/ecology/index.htm
Climatographs:
http://earthobservatory.nasa.gov/Laboratory/Biome/graphmatch_advanced.html
Biomes: http://www.mbgnet.net/
http://www.cotf.edu/ete/modules/modules.html
http://www.cotf.edu/ete/modules/msese/earthsysflr/tundra.html
http://www.ucmp.berkeley.edu/glossary/gloss5/biome/index.html

What else is in this handout?

First a note on pagination. This first section of text has a numerical number. The remainder of the packet is numbered with an "H" (handout) and then the number. I numbered the handout pages after they were reduced to 2 pages per sheet. The result is that most H pages actually contain two pages of information.

Most of the pages contain questions about the diagrams or graphs. You might use these as examples of what might appear in an Ecology event.