Option C: Ecology Notes Guide

The *can you* statements tell you what you notes should enable you to do. They are guidance to a minimum expectation. The deeper your understanding the easier you will find it to respond to questions and communicate your understanding. You should elaborate on these questions with examples (most of the paper three will be examples) and enough detail to understand the material. When examples are provided, elaborate on them because that is how MOST of the paper 3 questions will be posed.

**C1 Communities**

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|  | Can You…   * Explain how both abiotic and biotic limiting factors can affect the distribution of plant and animal species   + Provide examples   + List/describe limiting factors * Explain how quadrats/transects are used to measures species distribution. Be able to use a quadrat or transect to analyze distribution. (in class)   + Model species distribution using a kite graph * Describe Shelford’s Law of Tolerance (draw a sketch of the graph)   + Ex: coral reefs and zooxanthellae, black mangroves, glycophytes vs. halophytes (plants) * Explain/define the different interactions among species within a community   + Herbivory   + Predation (be able to analyze a graph of predation)   + Competition   + Symbioses     - Mutualism (ex: bee and flower, bird and crocodile, zooxanthellae and corals)     - Commensalism (ex: remora and shark, butterfly and milkweed, decorator crab and sea sponge)     - Parasitism (ex: ticks, leaches, bed bugs, etc. with hosts) * Describe IN DETAIL mutualistic relationship between Zooxanthellae and coral reefs. Explain how this is connected with coral bleaching * Define ecological niche and include a description of what in entails (habitat, activity patterns, resources, interactions, etc.)   + Explain the difference between fundamental vs realized niche * Explain what happens when two species have different niches vs. share a niche in a community   + Outline competitive exclusion vs. resource partitioning * Describe what a keystone species is and its importance to its ecosystem. Discuss what happens when a keystone species is removed.   + Examples: sea otters, sea stars, honey bees, beavers, Yellowstone wolves |
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**C2 Ecosystems**

Can You…

* Define/explain the trophic levels (producer, primary/secondary/tertiary consumer)
* Outline the difference between food chains/webs and be able to pick out trophic levels if given one
* Define ecological production and biomass. (in class)
  + Explain 10% rule (90% of energy lost as goes up trophic levels, only 10% passed on)
  + Know what energy is lost to as it goes up the food chain
  + Calculate primary production
  + Calculate secondary production
* Describe the feed conversion ratio and how to use it (in class)
* Explain the difference between an open vs. closed ecosystem
* Define biome (in terms of ecosystems) and describe the major factors that influence biomes (temp, rainfall, plant/animal species)
  + Characterize general climate of biomes (Don’t have to memorize! But refresh on characteristics)
    - Tropical rainforest, temperate forest, taiga, savannah, grassland, desert, tundra
  + Don’t have to memorize individual biomes, but DO have to analyze climographs (ex: Whitaker’s climographs)
  + Compare energy pyramids for different ecosystems (see bioninja)
* Construct/Analyze Gershmehl diagrams to show how nutrients flow and are stored in an ecosystem (in class)
* Explain the process of primary succession
  + When does it occur?
  + What is a climax community?
  + What is sequence of events?
  + Analyze graphs showing primary succession (see bioninja)
* Explain how ecological disturbances (ex: natural disasters) lead to secondary succession
  + Describe sequence of events
  + Describe how deforestation can impact nutrient cycling
  + Describe ways we can use to measure the level of ecological disturbance in an area

**C3 Human Impact**

Can you…

* Define what an invasive species is and explain how they negatively impact existing ecosystems
  + Explain IN DETAIL some examples (include where they came from, where were introduced, and effects)
  + Case studies: cane toads, wild rabbits, kudzu, lionfish, boa constrictor, etc.
* Explain how both invasive species, coupled with competitive exclusion, can impact the number of endemic species in an area (see bioninja)
* Explain the major methods of population control that are used to try to reduce the impact of invasive species (physical, chemical, and biological control)
  + Case study: Vedalia beetle
* Define biomagnification and explain its effects on trophic levels in food chains
  + Ex: DDT and effect on bird eggshell thickness (be able to analyze graph showing effects too – see bioninja)
  + Explain how DDT was used to treat insect-borne pathogens (like malaria) and be able to discuss the tradeoffs associated with DDT pollution and malaria control (see arguments on bioninja)
* Explain the negative effects of plastic pollution (particularly in marine environments
  + What is a POP
  + What is the difference between macro and microplastics?
  + Case study – albatrosses and sea turtles

**C4 Conservation of Biodiversity**

Can you…

* Explain what an indicator species is and how they can be used to assess the health of the environment
  + Examples: lichen, tubifex, mayfly larva
* Be able to calculate a biotic index (using a formula) to assess the proportion of pollution-tolerant vs pollution-intolerant species in an area (in class)
  + What does a high vs low biotic index indicate?
* Define biodiversity and describe the two main components that contribute to biodiversity
  + species richness and species evenness
* Use Simpsons reciprocal index to measure the relative biodiversity of a given community (in class)
  + What does a high index value suggest? Low index?
  + What can cause the index value to change in an area?
* Explain how various biogeographic factors (edge effect, habitat corridors, sunlight, niches, etc.) can affect biodiversity (see bioninja)
* Explain in depth how island size and edge effect impacts biodiversity of an area
* Describe various conservation efforts used to protect and maintain natural resources – like trees, water, and wildlife
  + Explain the difference between *in situ* vs *ex situ* conservation – discuss types and advantages/disadvantages of each
  + Case studies: Indian rhinos, mountain chicken frog, red wolves

**C5 Population Ecology**

Can you…

* Discuss the four factors that would cause a population to increase or decrease (natality, mortality, immigration, emigration)
* Describe methods used to estimate population size. How are they made more accurate?
  + Population sampling (random)
  + Different sampling methods for motile vs non-motile species
* Explain the process of capture-mark-release-recapture to estimate animal population sizes
  + Use the Lincoln Index equation to estimate population size – what assumptions must be true? What can improve accuracy (in class)
* Describe the difference between exponential vs logistic growth
  + J curve vs S curve
  + What type occurs when resources are unlimited? When resources begin to become limited and growth slows?
  + Define carrying capacity
* Describe density dependent and density independent factors that can limit/control the rate of population growth
* Explain the stages involved in the sigmoid growth curve (lag phase, exponential growth phase, transitional phase, plateau phase)
  + Draw the graph, and label it
  + Explain how yeast and duckweed can be used to model the sigmoid curve of population growth
* Describe the difference between top down control and bottom up control in terms of how limiting factors exert influence on the rate of population growth
  + Ex: bottom up control (algal blooms) and top down control (herbivory)
* Define sustainability and sustainable yield
  + Explain what maximum sustainable yield is and how we can estimate commercial stock
  + Describe sustainable fishing practices

**C6 Nitrogen and Phosphorus Cycles**

Can you…

* Draw and label a diagram of the nitrogen cycle
  + Understand the importance of bacteria being able to convert atmospheric nitrogen into a form that plants and animals can take up and use (to make proteins and nucleotides)
* Explain the processes of nitrogen fixation, ammonification, denitrification, nitrification
* Explain the impact of waterlogging (soil inundated with water) on the nitrogen cycle
  + How does it impact nitrogen levels in soil?
  + How does it impact loss of nitrates due to denitrification and leaching?
  + Discuss how insectivorous plants have adaptations for waterlogged soils
* Phosphorus Cycle
  + What is phosphorus used to build in living organisms?
  + Briefly explain how phosphorus is cycled in the environment
  + How does the rate of turnover of phosphorus compare to nitrogen? Why?
* Explain how fertilizers impact phosphate levels and how this affects areas where phosphorus is deposited/harvested from
* Describe how phosphate may become a limiting factor to agriculture in the future
* Explain the process of eutrophication
  + What causes the initial algal blooms?
  + What happens to dissolved oxygen levels in water bodies? Why?
  + How does this act similar to a positive feedback loop?
* Assess the nutrient content of a soil sample
  + Soil content: organic matter, rock, minerals
  + Testing soil for different components: pH, nutrients, texture, water content
  + How this impacts viability of soil for planting purposes

**IB Objectives for Option C**

**C1 Communities**

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| C.1.U1 | The distribution of species is affected by limiting factors. |
| C.1.U2 | Community structure can be strongly affected by keystone species. |
| C.1.U3 | Each species plays a unique role within a community because of the unique combination of its spatial habitat and interactions with other species. |
| C.1.U4 | Interactions between species in a community can be classified according to their effect. |
| C.1.U5 | Two species cannot survive indefinitely in the same habitat if their niches are identical. |
| C.1.A1 | Distribution of one animal and one plant species to illustrate limits of tolerance and zones of stress. |
| C.1.A2 | Local examples to illustrate the range of ways in which species can interact within a community. |
| C.1.A3 | The symbiotic relationship between Zooxanthellae and reef-building coral reef species. |
| C.1.S1 | Analysis of a data set that illustrates the distinction between fundamental and realized niche. |
| C.1.S2 | Use of a transect to correlate the distribution of plant or animal species with an abiotic variable. |

**C2 Ecosystems**

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| C.2.U1 | Most species occupy different trophic levels in multiple food chains. |
| C.2.U2 | A food web shows all the possible food chains in a community. |
| C.2.U3 | The percentage of ingested energy converted to biomass is dependent on the respiration rate. |
| C.2.U4 | The type of stable ecosystem that will emerge in an area is predictable based on climate. |
| C.2.U5 | In closed ecosystems energy but not matter is exchanged with the surroundings. |
| C.2.U6 | Disturbance influences the structure and rate of change within ecosystems. |
| C.2.A1 | Conversion ratio in sustainable food production practices. |
| C.2.A2 | Consideration of one example of how humans interfere with nutrient cycling. |
| C.2.S1 | Comparison of pyramids of energy from different ecosystems. |
| C.2.S2 | Analysis of a climograph showing the relationship between temperature, rainfall and the type of ecosystem. |
| C.2.S3 | Construction of Gersmehl diagrams to show the inter-relationships between nutrient stores and flows between taiga, desert and tropical rainforest. |
| C.2.S4 | Analysis of data showing primary succession. |
| C.2.S5 | Investigation into the effect of an environmental disturbance on an ecosystem. [Examples of aspects to investigate in the ecosystem could be species diversity, nutrient cycling, water movement, erosion, leaf area index, among others.] |

**C3 Human Impact**

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| C.3.U1 | Introduced alien species can escape into local ecosystems and become invasive. |
| C.3.U2 | Competitive exclusion and the absence of predators can lead to reduction in the numbers of endemic species when alien species become invasive. |
| C.3.U3 | Pollutants become concentrated in the tissues of organisms at higher trophic levels by biomagnification. |
| C.3.U4 | Macroplastic and microplastic debris has accumulated in marine environments. |
| C.3.A1 | Study of the introduction of cane toads in Australia and one other local example of an alien species. |
| C.3.A2 | Discussion of the trade-off between control of the malarial parasite and DDT pollution. |
| C.3.A3 | Case study of the impact of marine plastic debris on Laysan albatrosses and one other named species. |
| C.3.S1 | Analysis of data illustrating the causes and consequences of biomagnification. |
| C.3.S2 | Evaluation of eradication programmes and biological control as measures to reduce the impact of alien species. |

**C4 Conservation of Biodiversity**

C.4.U1 An indicator species is an organism used to assess a specific environmental condition.

C.4.U2 Relative numbers of indicator species can be used to calculate the value of a biotic index.

C.4.U3 In situ conservation may require active management of nature reserves or national parks.

C.4.U4 Ex situ conservation is the preservation of species outside their natural habitats.

C.4.U5 Biogeographic factors affect species diversity.

C.4.U6 Richness and evenness are components of biodiversity.

C.4.A1 Case study of the captive breeding and reintroduction of an endangered animal species.

C.4.A2 Analysis of the impact of biogeographic factors on diversity limited to island size and edge effects.

C.4.S1 Analysis of the biodiversity of two local communities using Simpson's reciprocal index of diversity. [The formula for Simpson’s index should be known by students.]

**C5 Population Ecology**

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| C.5.U1 | Sampling techniques are used to estimate population size. |
| C.5.U2 | The exponential growth pattern occurs in an ideal, unlimited environment. |
| C.5.U3 | Population growth slows as a population reaches the carrying capacity of the environment. |
| C.5.U4 | The phases shown in the sigmoid curve can be explained by relative rates of natality, mortality, immigration and emigration. |
| C.5.U5 | Limiting factors can be top down or bottom up. |
| C.5.A1 | Evaluating the methods used to estimate the size of commercial stock of marine resources. |
| C.5.A2 | Use of the capture-mark-release-recapture method to estimate the population size of an animal species. |
| C.5.A3 | Discussion of the effect of natality, mortality, immigration and emigration on population size. |
| C.5.A4 | Analysis of the effect of population size, age and reproductive status on sustainable fishing practices. |
| C.5.A5 | Bottom-up control of algal blooms by shortage of nutrients and top-down control by herbivory. |
| C.5.S1 | Modelling the growth curve using a simple organism such as yeast or species of Lemna. |

**C6 Nitrogen and Phosphorus Cycles**

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| C.6.U1 | Nitrogen-fixing bacteria convert atmospheric nitrogen to ammonia. |
| C.6.U2 | Rhizobium associates with roots in a mutualistic relationship. |
| C.6.U3 | In the absence of oxygen denitrifying bacteria reduce nitrate in the soil. |
| C.6.U4 | Phosphorus can be added to the phosphorus cycle by application of fertilizer or removed by the harvesting of agricultural crops. |
| C.6.U5 | The rate of turnover in the phosphorus cycle is much lower than the nitrogen cycle. |
| C.6.U6 | Availability of phosphate may become limiting to agriculture in the future. |
| C.6.U7 | Leaching of mineral nutrients from agricultural land into rivers causes eutrophication and leads to increased biochemical oxygen demand. |
| C.6.A1 | The impact of waterlogging on the nitrogen cycle. |
| C.6.A2 | Insectivorous plants as an adaptation for low nitrogen availability in waterlogged soils. |
| C.6.S1 | Drawing and labelling a diagram of the nitrogen cycle. |
| C.6.S2 | Assess the nutrient content of a soil sample. |