AP ENVIRONMENTAL SCIENCE

# UNIT 3

# Populations

**10–15%**
AP EXAM WEIGHTING

**~12–13**
CLASS PERIODS

UNIT 3

**10–15%** AP EXAM WEIGHTING | **~12–13** CLASS PERIODS

# Populations

**BIG IDEA 2**
***Interactions Between Earth Systems*** ERT
- How do changes in habitats influence changes in species over time?

**BIG IDEA 3**
***Interactions Between Different Species and the Environment*** EIN
- How is educational opportunity for women connected to human population changes?

## Developing Understanding

Populations within ecosystems change over time in response to a variety of factors. This unit examines the relationship between the type of species and the changes in a habitat over time. Specialist species are advantaged by habitats that remain constant, while generalist species tend to be advantaged by habitats that are changing. Different reproductive patterns, including those exhibited by K- and r-selected species, also impact changes to population. Population growth is limited by environmental factors, especially by the availability of resources and space. In subsequent units, students will explore how increases in populations affect earth systems and resources, land and water use, and energy resources.

## Building the Science Practices

5.A 5.C 5.E 6.B

Comparing trends and patterns in data helps students interpret experimental data in order to explain environmental changes that occur over time. These skills can help predict short- and long-term changes in an environment. As students build their skills in data analysis, they will learn how the data illustrate environmental concepts. It is also important that they learn to predict patterns and trends based on information provided in graphs and tables. Analyzing population growth, age structure diagrams, and survivorship curves can help students develop these skills.

While calculator use is permitted on the AP Exam, students still have to show their work, including the numbered steps they used to obtain an answer, with appropriate units. Without the appropriate units, a calculation is meaningless, even with correct computation. In this unit, students may benefit from having multiple opportunities to practice calculations such as population growth and the application of the rule of 70. Students can also practice selecting the appropriate calculation that is required in the analysis of a data set.

## Preparing for the AP Exam

On the AP Exam, students must be able to explain trends in population data for organisms. To practice this, students can look at a variety of human population graphs from various countries and then explain the trends in the data to draw conclusions about changes in the populations. This is also an opportunity for students to explain population density and population growth. Students can also practice interpreting population growth curves for other species. When explaining the survival of a species, students should consider population size and emphasize problems associated with reduced genetic diversity. It is helpful for students to connect data represented by tables, charts, and graphs to real-life examples of population changes.

SUGGESTED SKILL

*Concept Explanation*

1.B

Explain environmental concepts and processes.

AVAILABLE RESOURCES

- Classroom Resource > AP Environmental Science Teacher's Guide

# TOPIC 3.1
# Generalist and Specialist Species

## Required Course Content

### ENDURING UNDERSTANDING

ERT-3

Populations change over time in reaction to a variety of factors.

### LEARNING OBJECTIVE

ERT-3.A

Identify differences between generalist and specialist species.

### ESSENTIAL KNOWLEDGE

ERT-3.A.1

Specialist species tend to be advantaged in habitats that remain constant, while generalist species tend to be advantaged in habitats that are changing.

# TOPIC 3.2
# K-Selected r-Selected Species

**SUGGESTED SKILL**

*Data Analysis*

**5.A**

Describe patterns or trends in data.

**AVAILABLE RESOURCES**

- Classroom Resource > **AP Environmental Science Teacher's Guide**

## Required Course Content

### ENDURING UNDERSTANDING

**ERT-3**

Populations change over time in reaction to a variety of factors.

### LEARNING OBJECTIVE

**ERT-3.B**

Identify differences between K- and r-selected species.

### ESSENTIAL KNOWLEDGE

**ERT-3.B.1**

K-selected species tend to be large, have few offspring per reproduction event, live in stable environments, expend significant energy for each offspring, mature after many years of extended youth and parental care, have long life spans/life expectancy, and reproduce more than once in their lifetime. Competition for resources in K-selected species' habitats is usually relatively high.

**ERT-3.B.2**

r-selected species tend to be small, have many offspring, expend or invest minimal energy for each offspring, mature early, have short life spans, and may reproduce only once in their lifetime. Competition for resources in r-selected species' habitats is typically relatively low.

**ERT-3.B.3**

Biotic potential refers to the maximum reproductive rate of a population in ideal conditions.

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## LEARNING OBJECTIVE

ERT-3.B

Identify differences between K- and r- selected species.

## ESSENTIAL KNOWLEDGE

**ERT-3.B.4**

Many species have reproductive strategies that are not uniquely r-selected or K-selected, or they change in different conditions at different times.

**ERT-3.B.5**

K-selected species are typically more adversely affected by invasive species than r-selected species, which are minimally affected by invasive species. Most invasive species are r-selected species.

# TOPIC 3.3
# Survivorship Curves

**SUGGESTED SKILL**

*Data Analysis*

**5.C**

Explain patterns and trends in data to draw conclusions.

**AVAILABLE RESOURCE**

- Classroom Resource > AP Environmental Science Teacher's Guide

## Required Course Content

### ENDURING UNDERSTANDING

**ERT-3**

Populations change over time in reaction to a variety of factors.

### LEARNING OBJECTIVE

**ERT-3.C**

Explain survivorship curves.

### ESSENTIAL KNOWLEDGE

**ERT-3.C.1**

A survivorship curve is a line that displays the relative survival rates of a cohort—a group of individuals of the same age—in a population, from birth to the maximum age reached by any one cohort member. There are Type I, Type II, and Type III curves.

**ERT-3.C.2**

Survivorship curves differ for K-selected and r-selected species, with K-selected species typically following a Type I or Type II curve and r-selected species following a Type III curve.

**SUGGESTED SKILL**

*Data Analysis*

**5.E**

Explain what the data implies or illustrates about environmental issues.

**AVAILABLE RESOURCES**

- Classroom Resource > **AP Environmental Science Teacher's Guide**

# TOPIC 3.4
# Carrying Capacity

## Required Course Content

### ENDURING UNDERSTANDING

**ERT-3**

Populations change over time in reaction to a variety of factors.

| LEARNING OBJECTIVE | ESSENTIAL KNOWLEDGE |
|---|---|
| **ERT-3.D**<br>Describe carrying capacity. | **ERT-3.D.1**<br>When a population exceeds its carrying capacity (carrying capacity can be denoted as K), overshoot occurs. There are environmental impacts of population overshoot, including resource depletion. |
| **ERT-3.E**<br>Describe the impact of carrying capacity on ecosystems. | **ERT-3.E.1**<br>A major ecological effect of population overshoot is dieback of the population (often severe to catastrophic) because the lack of available resources leads to famine, disease, and/or conflict. |

# TOPIC 3.5
# Population Growth and Resource Availability

## Required Course Content

### ENDURING UNDERSTANDING

ERT-3

Populations change over time in reaction to a variety of factors.

### LEARNING OBJECTIVE

ERT-3.F

Explain how resource availability affects population growth.

### ESSENTIAL KNOWLEDGE

ERT-3.F.1

Population growth is limited by environmental factors, especially by the available resources and space.

ERT-3.F.2

Resource availability and the total resource base are limited and finite over all scales of time.

ERT-3.F.3

When the resources needed by a population for growth are abundant, population growth usually accelerates.

ERT-3.F.4

When the resource base of a population shrinks, the increased potential for unequal distribution of resources will ultimately result in increased mortality, decreased fecundity, or both, resulting in population growth declining to, or below, carrying capacity.

**SUGGESTED SKILL**

*Mathematical Routines*

6.B

Apply appropriate mathematical relationships to solve a problem, with work shown (e.g., dimensional analysis).

**AVAILABLE RESOURCES**

- Classroom Resource > **AP Environmental Science Teacher's Guide**
- The Exam > **Chief Reader Report 2017, Q1**
- The Exam > **Samples and Commentary 2017, Q1**

SUGGESTED SKILL

*Data Analysis*

5.C

Explain patterns and trends in data to draw conclusions.

AVAILABLE RESOURCES

- Classroom Resource > AP Environmental Science Teacher's Guide

# TOPIC 3.6
# Age Structure Diagrams

## Required Course Content

### ENDURING UNDERSTANDING

EIN-1

Human populations change in reaction to a variety of factors, including social and cultural factors.

### LEARNING OBJECTIVE

EIN-1.A

Explain age structure diagrams.

### ESSENTIAL KNOWLEDGE

EIN-1.A.1

Population growth rates can be interpreted from age structure diagrams by the shape of the structure.

EIN-1.A.2

A rapidly growing population will, as a rule, have a higher proportion of younger people compared to stable or declining populations.

# TOPIC 3.7
# Total Fertility Rate

**SUGGESTED SKILL**

*Data Analysis*

**5.A**

Describe patterns or trends in data.

**AVAILABLE RESOURCES**

- Classroom Resource > **AP Environmental Science Teacher's Guide**

## Required Course Content

### ENDURING UNDERSTANDING

**EIN-1**

Human populations change in reaction to a variety of factors, including social and cultural factors.

### LEARNING OBJECTIVE

**EIN-1.B**

Explain factors that affect total fertility rate in human populations.

### ESSENTIAL KNOWLEDGE

**EIN-1.B.1**

Total fertility rate (TFR) is affected by the age at which females have their first child, educational opportunities for females, access to family planning, and government acts and policies.

**EIN-1.B.2**

If fertility rate is at replacement levels, a population is considered relatively stable.

**EIN-1.B.3**

Factors associated with infant mortality rates include whether mothers have access to good healthcare and nutrition. Changes in these factors can lead to changes in infant mortality rates over time.

SUGGESTED SKILL

*Environmental Solutions*

7.A
Describe environmental problems.

AVAILABLE RESOURCES

- Classroom Resource > **AP Environmental Science Teacher's Guide**
- The Exam > **Chief Reader Report 2017, Q3**
- The Exam > **Student Performance Q&A 2016, Q1**
- The Exam > Samples and Commentary (**2017, Q3**, **2016, Q1**)

# TOPIC 3.8
# Human Population Dynamics

## Required Course Content

### ENDURING UNDERSTANDING

EIN-1

Human populations change in reaction to a variety of factors, including social and cultural factors.

### LEARNING OBJECTIVE

EIN-1.C.1

Explain how human populations experience growth and decline.

### ESSENTIAL KNOWLEDGE

EIN-1.C.1

Birth rates, infant mortality rates, and overall death rates, access to family planning, access to good nutrition, access to education, and postponement of marriage all affect whether a human population is growing or declining.

EIN-1.C.2

Factors limiting global human population include the Earth's carrying capacity and the basic factors that limit human population growth as set forth by Malthusian theory.

EIN-1.C.3

Population growth can be affected by both density-independent factors, such as major storms, fires, heat waves, or droughts, and density-dependent factors, such as access to clean water and air, food availability, disease transmission, or territory size.

EIN-1.C.4

The rule of 70 states that dividing the number 70 by the percentage population growth rate approximates the population's doubling time.

# TOPIC 3.9
# Demographic Transition

**SUGGESTED SKILL**

*Concept Explanation*

**1.C**

Explain environmental concepts, processes, or models in applied contexts.

**AVAILABLE RESOURCES**

- Classroom Resource > **AP Environmental Science Teacher's Guide**

## Required Course Content

### ENDURING UNDERSTANDING

**EIN-1**

Human populations change in reaction to a variety of factors, including social and cultural factors.

### LEARNING OBJECTIVE

**EIN-1.D**

Define the demographic transition.

### ESSENTIAL KNOWLEDGE

**EIN-1.D.1**

The demographic transition refers to the transition from high to lower birth and death rates in a country or region as development occurs and that country moves from a pre-industrial to an industrialized economic system. This transition is typically demonstrated through a four-stage demographic transition model (DTM).

**EIN-1.D.2**

Characteristics of developing countries include higher infant mortality rates and more children in the workforce than developed countries.