Life Science Lesson Plan (5E Model)

Grade Level: Middle School

Topic: ***Population Growth & Limiting Factors***

Concept Flow Chart:
Populations > Exponential Growth > limiting factors (food, water, oxygen, predators) > changes in ecosystem impact populations

Link to Curriculum Map and Cross Cutting Concepts:

- **Where We've Been** *(past lessons / grade levels):*
  - Plants and animals have adaptations that enable them to survive **[Structure and Function; Cause & Effect; Patterns]**
  - Ecosystems consist of biotic and abiotic factors. **[Structure and Function; Patterns]**
  - Organisms have interdependent relationships with one another within an ecosystem (including competition, predation, and symbiosis). **[Cause & Effect; Patterns; Energy & Matter]**
  - Organisms impact their ecosystems in various ways. **[Cause & Effect; Patterns]**
- **Where We Are** *(this lesson):*
  - The scientific definition for populations is very different from the common use of the word.**[Structure and Function]**
  - Population growth is affected by birth rate and death rate, which are both affected by the biotic and abiotic (limiting) factors within a population's ecosystem. **[Structure and Function; Cause & Effect; Patterns]**
  - Population growth (including exponential growth) can be modeled using graphs. **[Cause & Effect; System Models; Scale, Proportion and Quantity]**
  - Changes to ecosystems have predictable consequences on populations and growing populations have predictable impacts on ecosystems. **[Cause & Effect; Patterns; Stability and Change]**
- **Where We're Going** *(future lessons / grade levels):* **(MS - middle school) (HS - high school)**
  - Energy and matter move through ecosystems, which can be modeled using food webs (MS) and energy pyramids (HS) **[Cause & Effect; Patterns; Energy & Matter; System Models; Scale, Proportion and Quantity]**
  - Water as a limiting factor contributes to the various biomes found on earth (HS) **[Cause & Effect; Systems; Patterns]**
  - Characteristics of ecosystems make some adaptations more or less advantageous than others, and thereby affect the fitness of individual organisms and whole populations (HS) **[Structure and Function; Cause & Effect; Patterns]**
  - Human activity results in predictable changes to ecosystems (MS, HS) **[Stability and Change; Cause & Effect]**

Engagement	Exploration	Explanation	Elaboration	Evaluation
• Phenomena (engage student interest with a question, problem or challenge) • Driving Questions (access prior knowledge and organize students' thinking towards desired learning outcomes) • What differentiation will be needed for various learners?	• Hands-on activity • Teacher guides towards Big Ideas • Make Observations (quantitative and qualitative data) • Students compare and collaborate with one another • Teacher identifies current conceptions, processes, and skills and facilitates conceptual changes.	• Review of supporting Literature • Class discussion centered around CER (claim, evidence, reasoning) (students share their explanations before teacher, including vocabulary) • Help students connect their exploration to the concept under examination by focusing students on a particular aspect of their exploration • Point out scientific principles and techniques used during the lesson • Formative assessment (provides students with opportunities to demonstrate their skills and/or conceptual understanding)	• Challenge and extend students' conceptual understanding and skills in order to develop more sophisticated understanding of the concepts • Follow up activities to practice applying principles to new situations and real life	• Formative: Teacher listens to discussions throughout lesson • Summative: Final project, exam and/or student notebook • Are students using evidence and reasoning to support claims? Are they meeting the objectives of the SEP and DCI being addressed? • Important for students to learn to self reflect (evaluate own progress towards achieving the learning objectives) • Rubrics help both teachers and students with evaluation
1. Preassessment (Day 1) - Assesses Prior Knowledge about populations via notebook questions **2. Water Lilly Challenge - Part 1 (Day 1) -** Assesses Prior Knowledge about biotic, abiotic, and symbiotic relationships	**3. Water Lilly Challenge - Part 2 (Day 2) -** Model and graph exponential growth, and examine factors that affect growth	4. **Exponential Growth Mini-Lesson (Day 3)** - "One Grain of Rice" story/PPT illustrating exponential growth (math connection), "Choose Your Wages" activity, and PPT lecture (note-taking practice) on population growth, limiting factors, and human population	**5. The Naturalist's Dilemma (Day 4)** - Students use graphing and data analysis skills to solve challenge	**(Day5)** **6. Optional Assessments** (can be used for formative earlier in lesson or summative at end, alone or integrated into an exam) - **Burmese Python CER** - **Moose-Wolf CER** - **Graphing Performance Task** **7. Post-assessment**

Engagement (Day 1)

1. Preassessment: (10 min)
    a. **Students answer the following on top half of page in their notebook, titled "Populations 1.1":**
        1) What is a population? 2) What factors affect the size of a population?
    b. Students discuss their answers with a partner (pair share) and make revisions to their writing
        i. Teacher looks at writing and listens to discussions to determine background knowledge of students
        ii. Note that the scientific definition of a population is very different from the common use of the term. In science, a population is a group of organisms that all belong to the same species and live in the same defined area (ecosystem).

2. Water Lily Challenge - *Part 1: Access Prior Knowledge* (30 minutes)
    a. **Students observe a photo of a pond with a *population* of water lilies floating on it and complete the following on bottom half of page in their notebook, titled "Populations 1.2":**
        Sketch what you see in the photo and then answer the following two questions:
        1) What are the biotic and abiotic factors in this ecosystem?
        2) In what ways do the organisms in this environment interact with one another and with the abiotic factors
        i. Teacher may need to remind students of definitions for biotic and abiotic; point out that 'a' means 'not'
        ii. Students should identify interactions that involve competition for abiotic factors like water and light, and for biotic factors like plants and animals for food, to include predator/prey relationships; more advanced students may identify examples of symbiosis.

        - Alternatively, teacher could use this more in-depth STEMscope sequence:
        https://ali1.acceleratelearning.com/scopes/474/elements/17139
    b. Pair share, self-reflect, and make additions/revisions to notebook entry in a different colored ink
    c. Class Discussion
        i. Ask students to share their answers to questions 1 and 2
        ii. Ask students to group together similar relationships (predator/prey for example)
        iii. Organize student answers into a table or other type of graphic organizer that identifies: biotic factors, abiotic factors, and symbiotic relationships.

            Note: There are many types of symbiosis (close interdependent relationships between organisms):
            Mutualism - Both populations benefit from the symbiotic relationship.
            Commensalism - Symbiont benefits with little effect on the host population.
            Parasitism - Symbiont benefits to the detriment of the host population, but does not directly kill the host.
            Competition - Populations inhibit one another.
            Predation - Predator population kills and consumes prey population.

            Student backgrounds will differ; while you may discuss the types of symbiosis, they are not the focus of the lesson and so the goal should be to increase familiarity with symbiosis, not mastery. However, students should develop a strong understanding of *competition* and *predation*.
        iv. Students copy or paste graphic organizer into their notebook, under the "Populations 1.2" section.
            Posting graphic organizer online would enable students to print it and paste it into their notebook.

Exploration (Day 2)

3. Water Lily Challenge - *Part 2* (45 minutes)

   a. **Students work in groups to solve math challenge**:

      i. Divide class into groups of 2-4 students

      ii. Give each group a circle of blue construction paper with a diameter of about four inches, and a cup of green lentils (or other small, round, green object that sufficiently represents lily pads), and a sheet of graph paper for each team member.

      iii. Tell Students:
      On the first day of spring a single water lily was growing in the pond. Every week thereafter, the number of lilies doubled, so that after the first week there were two, and after the second week there were four, and after the third week there were eight, and so on. How many weeks did it take for the entire pond to be covered with water lilies? Use the blue circle and the green lentils to model the pond and lilies respectively.

      Point out to students that in a truly scientific model, you would need to be sure that the parts are in scale to one another. So this model would only be scientifically accurate if the ratio of the size of the lentils to the size of the blue circle was equivalent to the ratio of the size of the pond to the size of the lilies.

      iv. Tell students to create a graph that communicates lily population growth over time. Students should use the x-axis to represent time (weeks) and the y-axis to represent the size of the population (number of lily pads).

   b. Class Discussion: Students share and compare their results, and explore factors that affect population size. Emphasis is on exploring the factors that cause changes in population size and leading questions should include: (Employ pair share prior to whole class discussion to keep students fully engaged.)

      i. If we all had the same sized pond, why didn't we all get the same answer? That is, why did it take some populations longer than others to cover the lake?
      The lily pads (and lentils) are of slightly different sizes.

      ii. What does the shape of the graph look like? Why is the graph a curve and not a line?
      The graph is a curve that quickly gets steeper. This is because the y-variable increases more rapidly than the x-variable.

      iii. What do you expect the graph to look like like after another few weeks? Will the curve continue to get taller? Explain.
      ***First**, the population will stop growing since the lilies have run out of space and new lilies will not have room to grow - the existing lilies will block them from receiving light. This will be reflected in the graph as a leveling out of the line. **Second**, the ecosystem cannot support such a large population indefinitely. Eventually the lilies will use up all of the nutrients in the water since there are too many for the environment to replenish the nutrients fast enough to support them all. As the nutrients become more scarce, the lilies will begin to die and the population growth will be negative. This will be reflected in the graph as a plummet in the line.*

      iv. What causes a population to grow?
      Reproduction (new births) - healthier organisms are more likely to reproduce than unhealthy organisms)

      v. What causes a population to decline?
      Deaths (could be due to disease or old age, or due to running out of resources like food, water, oxygen, carbon dioxide, and sunlight, or due to being eaten by a predator)

      vi. How would drought affect the inhabitants of the pond ecosystem?
      The amount of available water would shrink and therefore the size of the populations dependent on the water would decline. The lilies, for example, would not have enough space and so some, perhaps many, of them would die.

   c. **Homework or Exit Ticket:** *(can be assigned at a later time to accommodate teacher's class schedule)*
   Students answer "A Riddle to Remember" - *A particular pond has water lilies growing on it. On the first day, there is one water lily. Each day, the number of water lilies doubles. After 30 days, the water lilies cover half the pond. How long before they also cover the other half of the pond, so the whole pond is full?*

      i. Discuss answers the next day.

      ii. Follow up with, *"what percent of the pond was covered with lilies on Day 29?"*

Explanation (Day 3)

4. Exponential Growth Mini-Lesson

   a. **Students complete a warm up:** *"Choose Your Wages" challenge* (5 minutes)

   You are offered a job, which lasts for 7 weeks and you get to choose your salary.

   - *Either, you get $100 for the first day, $200 for the second day, $300 for the third day; and each day you are paid $100 more than the day before, or*
   - *You get 1 cent for the first day, 2 cents for the second day, 4 cents for the third day; and each day you are paid double what you were paid the day before.*

   Which do you choose?

   Allow students to discuss their answers with their partners but do not discuss the answers as a class yet.

   b. Teacher Presents "One Grain of Rice" Story (15 min)
   Book illustrations are on the PPT slides, but the words are printed on a separate sheet of paper for the teacher to read.

   c. **Revisit "Choose Your Wages" warm up challenge**: (5 min)
   give students time to 1) reflect on and revise their answers,followed briefly by 2) pair share, and 3) class discussion guided by PPT slides

   d. **Teacher presents lecture slides** - to practice note taking (20 min) *(use PowerPoint presentation for this lesson)*

   Teacher should model for students how to interact with their PPT notes. One good way to do this is to project the notes onto a white board and coach the students in how to highlight important information and add supplemental notes for clarification.

      i. Exponential growth of populations
      ii. Logistic growth of populations & limiting factors
      iii. Human population growth & impacts on the planet
         - Optional: Prior to starting this part of the presentation, have students analyze the "History of Human Population Growth" handout and comment on their observations.

           Record class observations and make sure students notice the stagnation in population growth around the time of the Bubonic Plague in the 13th and 14th centuries.

   e. Homework:

      i. Students view the following video: https://www.youtube.com/watch?v=x5OYmRyfXBY

      ii. Students answer the following questions in their notebook:
      1) How has the size of the human population changed over time?
      2) How have environmental changes affected the growth rate of the human population over time? What factors affect human population growth today? How do these compare to those 100 years ago? 10,000 years ago? 100,000 years ago?
      3) Will the human population continue to grow exponentially forever? Explain.
      4) How has growth of the human population affected the planet's systems and cycles, and natural resources?

      iii. Discuss answers the next day.

      Note that for most of history prior to 10,000 years ago before farming began, the human population remained small, experiencing periods of little growth and, at times, was on the verge of extinction. After the advent of farming, the human population began to grow slowly and steadily, until about 150 years ago, when technological advances in agriculture made it possible to grow more food on less land and technological advances in medicine (namely antibiotics) drastically reduced the number of deaths caused by communicable diseases. Then the population began to explode! Interestingly you can see the dip in the worldwide population caused by the black plague in the 14th century.

Elaboration (Day 4)

5. The Naturalist's Dilemma (30 - 45 min depending on how assign graphing)
    a. **Students use dataset handout to graph the six populations** *(Alternatively, teacher could have students work in groups of three and assign each student to graph two of the datasets each)*
    b. **Students work in groups to analyze the six population graphs** and try to figure out which species belongs to each graph. If the teacher wants to spend more time on this, could ask students to complete a CER in their notebook for some or all of the graphs arguing their claims.
    c. **Class Discussion** - see key for summary of distinguishing factors students should have identified

The connections here are very complex. The emphasis is on introducing students to thinking about the complex interrelationships between species, not on mastery. The emphasis is also on improving ability to analyze data.

Evaluation (Day 5)

6. Assessment Options
Teachers should be gradually moving towards performance based assessments, but not everyone is read. The options below could be used as formative assessments earlier in the lesson or as part of a summative assessment at the end of the lesson. When using these as a summative assessment, teachers may group several to create a more comprehensive assessment, or incorporate these into a more tradition exam format as a critical thinking piece.
    a. **Students complete the Burmese Python CER**: This activity emphasizes the role of predation as a limiting factor and the impact of introduced species on an ecosystem
    (*Science & Engineering Practices:* 4. Analyzing and Interpreting Data, 7. Engaging in Argument from Evidence)
    https://ali1.acceleratelearning.com/scopes/478/elements/17217
    b. **Students complete the Moose-Wolf CER followed by a class discussion:** (This activity emphasizes the complex relationship between the population growth of a predator and its prey - students have to read, interpret and analyze graphs; state a claim and argue from evidence)
    (*Science & Engineering Practices:* 4. Analyzing and Interpreting Data, 7. Engaging in Argument from Evidence)
    https://ali1.acceleratelearning.com/scopes/475/elements/17166
    c. **Graphing Performance Task**: Provide students with a dataset representing the growth of a population and ask students to graph it and calculate what the population will be in a specified time in the future, assuming there are no limiting factors. Then ask the students to answer questions that assess their understanding of the relationships between organisms in an environment:
    (*Science & Engineering Practices:* 4. Analyzing and Interpreting Data, 5 Using Mathematics and Computational Thinking, 7. Engaging in Argument from Evidence)
        i. How would the graph change if a new predator moved into this community (introduced species)?
        ii. How would the graph change if a natural disaster (hurricane, drought, etc) suddenly reduced the amount of available food? How would this compare to the change that would occur with a more gradual environmental change like global warming?

General Guidelines for CER (claim, evidence, response) Activities:

- *Students should work in pairs to complete the peer evaluation piece after they complete the CER assignment - helps students gain valuable feedback. Allow them to time to revise their responses either before they turn them in (formative assessments) or after they receive them back (summative assessment).*
- *Teacher should follow up each CER with class discussion to help students reflect on their answers and clarify any misperceptions*
- *Students should add each CER scenario and graded rubric to their notebook post-grading.*

7. **Post-assessment:**
    a. Students answer the following on a single page in their notebook and compare their response to that which they made when they answered this same set of questions at the start of the unit:
        1) What is a population?
        2) What factors affect the size of a population? Be sure to write a complete answer that includes at least five factors that affect the size of a population and explanations to support your claims.

This could be presented as a test and the students can affix it to their notebook after it is returned with grade