Author:	KC Jones
Author Affiliation and Location:	PaleoResearch Institute, Golden, CO
Lesson Plan Credit:	Adapted from isotopic lesson plans developed by Dr. Sammantha Holder, sammholder@gmail.com
Introduction (Lesson Plan Abstract):	Archaeologists rely on different kinds of evidence to interpret the past. One method for reconstructing past environments and foodways is through the study of **isotopic** or **biogeochemical** data. Students will *engage* with and *explore* the field of archaeological isotopic research using original data sets from the Charleston Cattle Economy Project. Carbon ($\delta^{13}C$) and Nitrogen ($\delta^{15}N$) isotopes extracted from cattle teeth have been used to explore the role of small-scale cattle farming in large-scale urban development, particularly the rise of Charleston, South Carolina, from the late 17th century to the mid-19th century. Students will be provided with stable isotopic data (values expressed as parts per million $^{0}/_{00}$ ratios) that they will plot on an X-Y axis of carbon and nitrogen values after a brief lesson about what isotopes are and how they help archaeologists investigate past environments and the foods animals and people ate. Students will then debrief with the instructor using provided discussion questions to *interpret* the diets of colonial cattle, and how these diets might inform archaeologists on how and where cattle were raised. **Note**: Students should be familiar with Cartesian coordinate systems and mapping on an X-Y axis prior to attempting this lesson.
List of Standards Addressed:	State Science Standards: • SB5 – Science Georgia Standards of Excellence, Biology • SBO5 – Science Georgia Standards of Excellence, Botany • SEC3 – Science Georgia Standards of Excellence, Ecology • SEV4 – Science Georgia Standards of Excellence, Environmental Science • H.B.6B.1 – South Carolina Biology Standards • H.E.3A.8 – South Carolina Academic Standards and Performance Indicators for Science, Earth Science Next Generation Science Standards: • MS-LS1-6 – Next Generation Science Standards, Middle School Life Sciences • MS-LS2-3 – Next Generation Science Standards, Middle School Life Sciences • HS-LS1-5 – Next Generation Science Standards, High School Life Sciences Social Studies Standards: • SS8H1.b. – Social Studies Georgia Standards of Excellence, 8th Grade, Historical Understandings • SSUSH1.b. – Social Studies Georgia Standards of Excellence, High School, United States History • SSWH10.d. – Social Studies Georgia Standards of Excellence, High School, World History • 8.1.CE – South Carolina Social Studies Standards, 8th Grade, Settlement and Development

Standards (Cont.)	• 8.1.P - South Carolina Social Studies Standards, 8th Grade, Settlement and Development • HG.5.5.PR - South Carolina Social Studies Standards, 9th Grade, Urban Land Use *For a complete list of primary and secondary science and social studies standards addressed through this lesson plan and its variants, please see appended list. Links to state and national standards are provided therein.*
Learning Objectives:	By the end of the lesson, students will be able to: • *Describe* what an isotope is; • *Analyze* the ways stable isotopes enter the bodies of people and animals; • *Identify* differences in isotopic values between archaeological samples; • *Organize* the provided archaeological data on a Cartesian plane; • *Interpret* how these differences in isotopic values might indicate differences in diets and environments; • *Compare* their results with their classmates and the answer key provided by the instructor
Appropriate Grade Levels:	Middle School (8th Grade), High School, Undergraduate introductory archaeology courses (with scaling in difficulty/additional readings and lectures)
Group Size, # of students activities are designed for:	This exercise is most effective in class sizes of less than 25-30 students, with small group break-outs optional so students can compare results before debriefing with instructor.
Setting:	Indoor classroom with desks/tables available for students
Approximate time of lesson:	45-60 minutes, depending on length of introductory lesson. Instructor should introduce isotopes, diet and environmental reconstruction, and Charleston project (~25-30 minutes). Activity should take ~10 minutes (graphing only), with instructor leading debrief and working through discussion questions with students for ~15 minutes.
Resources needed for students:	• Printed lesson plan activity sheet (two sheets, printed single-sided if possible so students can see their graphed results while working through discussion questions) • Desks/tables for students to work independently or in small groups
Resources needed for educators:	• PowerPoint (to display introductory lecture material and graphical results of the activity for students to compare their answers to)
Lesson Activity:	**Engage**: • Students will participate in a brief lecture on the nature of isotopes, how they enter the bodies of people and animals, and their utility in helping archaeologists answer questions of diet and environmental variability using the Charleston Cattle Economy Project as an example. • The instructor will link conceptual isotopic information to real-world applications through questions directed at students. Ex: "What would the isotopes in your body tell future archaeologists about what you ate?" **Explore**: • Students are either broken into small groups or may work individually and are provided with the printed isotopic data and a Cartesian plane with the $\delta^{13}C$ (X-axis) and $\delta^{15}N$ (Y-axis) values provided for several specimens

Lesson Activity (Cont.):	analyzed during the Charleston Cattle Economy Project from different locations in the study area. • Students are asked to plot the isotopic data on the provided Cartesian plane (instructor may want to demonstrate by plotting the first set of isotopic values with the class on a PowerPoint slide). Students will then work individually or in small groups to try and answer provided discussion questions. **Explain**: • The instructor will walk around the room and clarify graphing schema with students. • Students may want to share their Cartesian graphs with the class or swap with a partner prior to debriefing or having the answers provided by the instructor via overhead projection of the completed graph. • Instructor will work through the discussion questions with students, linking isotopic data from the activity with prior knowledge from the introductory lecture to explain similarities/differences in dietary resources among cattle in the study group. **Elaborate**: • At the end of the activity, students will hear about the results of the Charleston Cattle Economy Project, and how their activity reflects the real-world results of the work conducted in colonial Charleston.
Assessment/Evaluation:	Students will be qualitatively evaluated during the lesson for evidence of learning using the following criteria: • Evidence of linking concepts together, specifically tying isotopic raw data to interpretations of diet and environment • Ability to execute class activity on their own or in a group setting