Criollo vs. Angus Cattle *in a Changing Climate*

GET OUT AND GRAZE (GO AG!)

DESCRIPTION

Students learn about heritage livestock as they play the roles of Angus and Raramuri Criollo cattle grazing on a rangeland under abundant and then limited forage conditions caused by climate change.

PHENOMENON

How does reduced forage availability due to climate change affect two different cattle types?

GRADE LEVEL
6 – 12

OBJECTIVES

Students will:

- Compare and contrast a traditional, British cattle type with a heritage breed from Mexico
- Model the grazing behavior of cows under abundant and then limited resources
- Analyze resource acquisition under different availability scenarios
- Discuss the advantages and disadvantages of heritage livestock types under climate change conditions

TIME
60 MINUTES

COMMON CORE STATE STANDARDS

English Language Arts Standards » Science & Technical Subjects » Grade 6-8

CCSS.ELA-LITERACY.RST.6-8.4
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.

CCSS.ELA-LITERACY.RST.6-8.7. Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

English Language Arts Standards » Science & Technical Subjects » Grade 9-10

CCSS.ELA-LITERACY.RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

CCSS.ELA-LITERACY.RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

English Language Arts Standards » Science & Technical Subjects » Grade 11-12

CCSS.ELA-LITERACY.RST.11-12.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

Grade 6 » Statistics & Probability

CSS.MATH.CONTENT.6.SP.A.2
Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape. [Extension Activity]

Grade 7 » Statistics & Probability

CCSS.MATH.CONTENT.7.SP.B.3
Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability. [Extension Activity]

Grades 9-12 » Statistics & Probability

CCSS.MATH.CONTENT.HSS.ID.A.1
Represent data with plots on the real number line (dot plots, histograms, and box plots). [Extension Activity]

CCSS.MATH.CONTENT.HSS.ID.A.3
Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). [Extension Activity]

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NEXT GENERATION SCIENCE STANDARDS

Middle School Performance Expectation

MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

High School Performance Expectation

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models (MS, HS) Analyzing and Interpreting Data (MS) Constructing Explanations and Designing Solutions (MS, HS)	ESS3.A Natural Resources (HS) ESS3.C Human Impacts on Earth Systems (MS, HS) LS2.A Interdependent Relationships in Ecosystems (MS, HS)	Cause and Effect (MS, HS) Systems and System Models (MS, HS)

AGRICULTURE, FOOD, AND NATURAL RESOURCES STANDARDS

AS.01.01. Evaluate the development and implications of animal origin, domestication and distribution on production practices and the environment.
AS.01.01.01.c. Evaluate the implications of animal adaptations on production practices and the environment.

AS.01.03. Analyze and apply laws and sustainable practices to animal agriculture from a global perspective.
AS.01.03.02.a. Research and summarize sustainability in animal systems.

CS.04.02. Assess and explain the natural resource related trends, technologies and policies that impact AFNR systems.
CS.04.02.01.b. Analyze natural resources trends and technologies and explain how they impact AFNR systems (e.g., climate change, green technologies, water resources, etc.).

BACKGROUND

The bloodline of Raramuri Criollo (pronounced krē-ō-yō) cattle originated in Spain. In 1493, Columbus brought a small group to the New World from the Andalusia region of southern Spain. In 1627, Jesuit missionaries introduced Criollo cattle to the Sierra Tarahumara Indians in the Copper Canyon area of Mexico, and the Tarahumara have maintained the cattle with minimal husbandry or cross-breeding with other cattle breeds into the present time. Raramuri Criollo have undergone generations of natural selection in arid, rugged landscapes in Mexico. As a result, they are well adapted to dry conditions.

Raramuri Criollo cattle have a different body type than breeds typically used by ranchers in the Southwest, such as Angus. Criollo are smaller, and they have a more slender hind end and larger shoulders. On average, mother cows are about 800-900 pounds. Their body type allows them to move over steep and rocky terrain.

Angus cattle, which originated from a British bloodline, tend to be much larger and stockier than Criollo. Angus mother cows tend to grow as large as 1,100 pounds. They prefer to move over flat terrain. They usually concentrate their grazing on nutritious patches of grasses that are closer to water.

Research has demonstrated that Raramuri Criollo will cover significantly greater distances than conventional Angus to find forage in the extensive pastures of the Chihuahuan Desert. Raramuri Criollo cattle were found to travel twice the distance from water compared to the conventional breed during the same time period. As a result, Raramuri Criollo tend to need less supplemental feed than Angus. Supplemental feed, such as hay and cottonseed cakes, can be costly for ranchers. In addition to needing less supplemental feed, Raramuri Criollo may have less impact on the ecosystem. Researchers have suggested that Raramuri Criollo spread their impact over the landscape to a greater degree, and their use could help reduce some of the problems associated with localized overgrazing in arid landscapes.

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MATERIALS

- *Compare and Contrast* handout [1 per student]
- *Get Out and Graze* handout [1 per student]
- *Histogram Extension Activity* handout, printed single sided (optional) [1 per student]
- Labels for far and close "grazing site" bags (Figure 1)
- Location map for each grazing site station
- PowerPoint presentation
- Computer and projector
- 10 small paper bags, preferably 5 of each of 2 different colors if possible (Figure 1)
- Glue stick or scotch tape
- Packing tape
- 150 pennies, separated into two bags of 50 each and two bags of 25 each
- 5 green markers
- 5 blue markers
- 5 opaque bowls, cups, or plastic bags to serve as cow "rumens" during the game
- Optional: *Out on the Land* Season 7, Episode 85 video, 25-minute introduction to Raramuri Criollo cattle at the Jornada Experimental Range (https://vimeo.com/153841355)
- Optional: document camera

Figure 1. Small paper bags with grazing site labels attached

PREPARATION

1. Prepare the 5 close grazing sites and 5 far grazing sites by printing the labels, cutting out, and attaching one to each of the 10 small paper bags (Figure 1). Attach labels with a glue stick or scotch tape. If you have two different color bags, attach all of the "Close" labels to one color and all of the "Far" labels to the other color. Place a strip of packing tape inside the bottom of each paper bag to secure and cover up the bottom flap. The bag will be holding pennies, and when bags are not taped, the pennies tend to get trapped under the bottom flap during the game.
2. Locate a suitable space in the classroom or outside area, and then place the five close grazing sites and 5 far grazing site bags. Grazing site bags can be on tables or desks as long as there is adequate space for students to move freely between all 10 sites. Place the empty bags at the locations, open them, stand them up, and fold the top over so that the bags are closed. Figure 2 is a sample map for grazing site location placement (F= far grazing site bag and C=close grazing site bag).

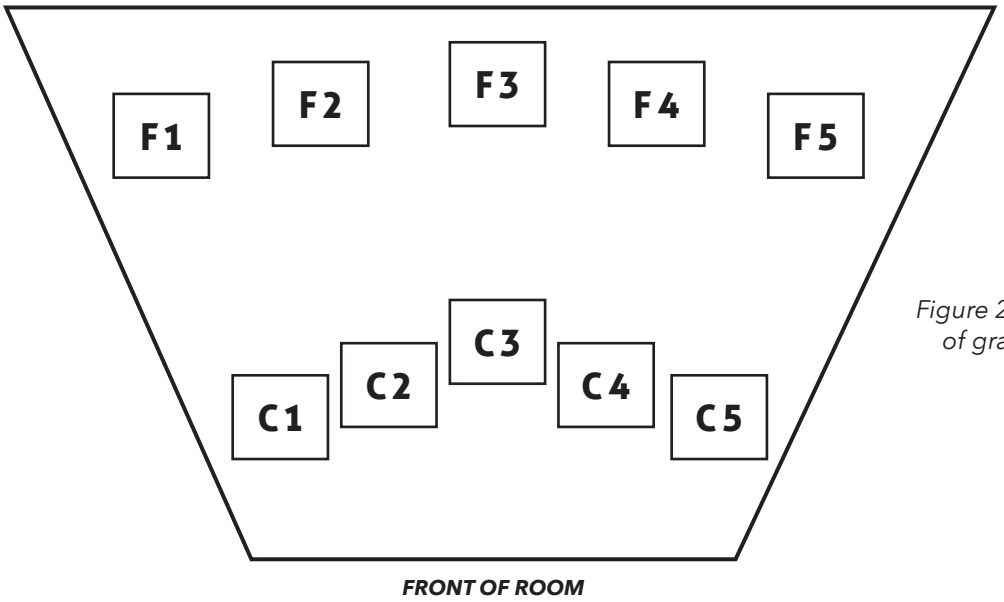

Figure 2. Sample map for placement of grazing sites, C=Close, F=Far

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3. Print out the location map, and cut along the lines to separate the map into 10 sections. Place one section of the grazing site location map next to each grazing site. Lay them out so that they follow the numbering of the sample map (Figure 2).
4. Draw the location map on the board or prepare to show it with a document camera.
5. Draw the Angus and Criollo tables from page 1 of the *Get Out and Graze* handout on the board or prepare to show them with a document camera.
6. Set up a computer and projector and display the PowerPoint presentation.
7. Optional: for helpful background information for the educator, watch the *Out on the Land* Season 7, Episode 85 video. Time permitting, it would be beneficial to show this video to students as well. Open the link on a computer attached to a projector to show the video if students will be viewing.

PROCEDURES

Introductory Compare and Contrast Activity

1. Pass out a *Compare and Contrast* handout to each student.
2. Use the PowerPoint presentation to introduce Criollo and Angus cattle.
   a. **Slide 2**: we will be playing a game related to cattle foraging patterns on the range. The two cattle breeds pictured will be involved in our game; they are called Criollo (pronounced krē-ō-yō) and Angus.
      i. Examine these two photos and answer questions 1-3 on the *Compare and Contrast* handout. [Ask students to share their answers, and lead a discussion of the similarities and differences of the two breeds. Similarities may include: they are the same species (or both cattle) and they have all of the same main body parts. Differences may include: Criollo is much smaller/weighs much less, Criollo is skinnier/Angus is bulkier, Angus does not have horns, Criollo originated in Africa/Angus originated in Europe.]
3. Optional: show the *Out on the Land* Season 7, Episode 85 video as an introduction to Criollo cattle in the Southwest.

Grazing Game – Explaining the Procedures and Making Predictions

1. Pass out a *Get Out and Graze* handout to each student.
2. Explain the game using the PowerPoint presentation.
   a. **Slide 3**: we will play a game in which you will play the roles of two different types of cattle. We will start by assigning roles, and then we will talk about how to play the game [assign students to roles].
      i. Five students – Angus for scenario 1
      ii. Five students – Criollo for scenario 1
      iii. Up to four students - Food distributors
      iv. One or two students – Location mappers
      v. One or two students – Data collectors
   b. **Slide 4**: in this first part of the game, **five** students will play the role of **Angus cows** grazing on a rangeland.
      i. There are 10 grazing sites total: five grazing sites close to the water station, near the front of the room, and five grazing sites far from the water station.
      ii. The food resources in the game are represented by pennies. The five close grazing sites have a total of 50 food resources (pennies) divided randomly between feeding sites. The five far grazing sites also have 50 food resources divided randomly between feeding sites.
   c. **Slide 5**: Angus are **reliant on nearby water**, so for the purposes of our game, they are **unable to travel to the far grazing sites** to collect food. They can only travel to the close grazing sites in our game because research shows that they prefer to stay close to water. The first trial of the game will focus on Angus. The second trial will involve Criollo, which are less reliant on water and can graze at both close and far grazing sites.
   d. **Slide 6**: there will be six rounds in the Angus trial. It is not a race; each cow will have time to graze at the grazing site s/he visits.
      i. In each round, cows move to a grazing site and collect the appropriate number of food resources for that location.
      ii. Cows at CLOSE grazing sites can get a maximum of THREE food resources per round.
      iii. There is a cost of both time and energy for a cow to move to far grazing sites, so cows at FAR grazing sites can get a maximum of TWO food resources per round.
      iv. More than one cow is allowed to visit a grazing site during a round. If there are two or more cows at a site, they must take turns getting food resources, up to the maximum allowed at that site (three or two).
      v. We will note the number of Angus cows that do not collect at least 10 food resources at the end of the trial. Cows that do not collect at least 10 food resources will have to be supplemented with additional hay and cottonseed cakes, which results in increased expenses for the rancher.
   e. **Slide 7**: if there are no more food resources at a grazing site, the cow must wait patiently until it is time to switch to a new grazing site.
      i. After the cow has collected food resources, s/he will **mark a dot on the paper**

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near the grazing site showing they were there. Angus cows will use blue markers, and Criollo will use green markers.

ii. Cows must move to a different grazing site each round, but they may return to a grazing site once they have left it for at least one round.

iii. We will conduct a total of six rounds.

iv. At the end of all six rounds, each cow will count the number of resources s/he was able to collect. We will examine how the herd did as well as how each cow did throughout the grazing cycle.

f. **Slide 8**: in the second part of the game, **five** students will play the role of **Criollo** cows grazing on a rangeland.

i. **Criollo** are able to **travel further from water**, so they can go to **either the close grazing sites or the far grazing sites**.

ii. Remember, there is a cost of both time and energy for a cow to move to far grazing sites, so cows at FAR grazing sites can get a maximum of TWO food resources per round.

iii. The five close grazing sites have a total of 50 food resources (pennies) divided randomly between feeding sites. The five far grazing sites have a total of 50 food resources divided randomly between feeding sites.

iv. We will note the number of Criollo cows that do not collect at least 7 food resources at the end of the trial. Criollo cattle are smaller than Angus and need fewer food resources to fuel their lighter bodies. Cows that do not collect at least 7 food resources will have to be supplemented with additional hay and cottonseed cakes, which results in increased expenses for the rancher.

v. The rest of the rules from the Angus trial also apply to the Criollo trial.

g. **Slide 9**: fill out the predictions box at the top of page 1 of the *Get Out and Graze* handout. Predict which cattle breed will need more supplemental feed because they will not collect enough food resources during the game, and then predict which breed will consume a greater percentage of the total resources available.

Grazing Game – Scenario 1 (abundant food)

1. While the rest of the class is **not** looking, have the food distributor(s) divide:
   a. 50 food resources (pennies) randomly in the close grazing site bags
   b. 50 food resources (pennies) randomly in the far grazing site bags

   Tell food distributors that there is no need to place exactly 10 pennies in each of the five bags. However, make sure there is a total of 50 pennies in close grazing sites and 50 pennies in far grazing sites. Once distributors have placed the pennies in the bags, they should fold the tops of the bags back down.
2. Pass out a "rumen" and a blue marker to each student playing the role of an Angus cow.
3. Get students started on trial 1 for Angus cows:
   a. **Slide 10**: using the rules and procedures explained before, the five **Angus cows** will now play the game. Remember that Angus cows **are reliant on nearby water**, so for the purposes of our game, they are unable to travel to the far grazing sites to collect food. In our game, they **can only travel to the close grazing sites** because research shows that they prefer to stay close to water.
      i. Prompt students who are playing Angus cows to choose a starting grazing site. Instruct them to graze, and remind them that they are to take three food resources at the close sites. If there is more than one cow at the grazing site, students will take turns getting resources up to a maximum of three per cow.
         1. Students will open the bag, and without looking in, collect three food resources. Then instruct students to close the bags by folding the tops back over.
         2. Students are to put the food resources into their rumens and wait patiently until it is time to switch.
         3. Tell students to be secretive about how many resources are available at each grazing site. If there are no resources left at a site, they should open the bag and act like they are taking resources and depositing them in their "rumens." They should not hint to other cows about the number of resources available at their site.

      ii. Instruct students to use the **blue** marker to make a dot on the paper at their grazing site to show that they were there.

      iii. Once all five Angus players have had the chance to graze at the first site, instruct students to switch. They must move to a different close grazing site.
         1. Remind students that cows can share a site; they will just take turns getting resources from the bag.
         2. Remind them that they must change locations, but they may return to a grazing site once they have left it for at least one round.

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iv. Repeat until Angus players have played six rounds.

4. Once the Angus players have been through all six rounds, have them count how many food resources they have collected.
5. Ask the data collector(s) to enter each cow's data on in the data table on the board (or use the document camera). Instruct each Angus player to call out their number of food resources one at a time. All students should fill in the Angus portion of the data table on page 1 of the handout.
   a. **Slide 11**: as the data collector(s) fill in the table on the board, you will fill in the Angus portion of the Abundant Resources data table on page 1 of the handout.
6. While students are filling in their table, have the food distributor(s) collect any remaining food resources from the close grazing sites.
7. Next, while the rest of the class is **not** looking, have the food distributor(s) randomly divide 50 food resources in the close grazing sites. There should still be 50 food resources randomly distributed in the far grazing sites. Tell food distributors to place the pennies in the bags and fold the tops of the bags back down.
8. Pass out a "rumen" and a green marker to each student playing the role of a Criollo cow.
9. Get students started on trial 2 for Criollo cows:
   a. **Slide 12**: using the rules and procedures explained before, the five **Criollo cows** will now play the game. Remember that Criollo are more likely to travel **further from water**, so they can go to either the **close grazing sites or the far grazing sites**. They may collect TWO food resources from far grazing sites and THREE food resources from close grazing sites.
      i. Prompt students who are playing Criollo cows to choose a starting grazing site. Instruct them to graze, and remind them that they are to take two food resources from far sites and three food resources at the close sites.
         1. Students will open the bag, and without looking in, collect two or three food resources, depending on the site. Then instruct students to close the bags by folding the tops back over.
         2. Students are to put the food resources into their rumens and wait patiently until it is time to switch.
         3. Tell students to be secretive about how many resources are available at each grazing site. If there are no resources left at a site, they should open the bag and act like they are taking resources and depositing them in their "rumens." They should not hint to other cows about the number of resources available at their site.
      ii. Instruct students to use the **green** marker to make a dot on the paper at their grazing site to show that they were there.
      iii. Once all five Criollo players have had the chance to graze at the first site, instruct students to switch. They must move to a different site, either close or far.
         1. Remind students that cows can share a site; they will just take turns getting resources from the bag.
         2. Remind them that they must change locations, but they may return to a grazing site once they have left it for at least one round.
      iv. Repeat until Criollo players have played six rounds.
10. Once the Criollo players have been through all six rounds, have them count how many food resources they have collected.
11. Ask the data collector(s) to enter each cow's data on in the data table on the board (or use the document camera). Instruct each Criollo player to call out their number of food resources one at a time. All students should fill in the Criollo portion of the data table on page 1 of the handout.
    a. **Slide 13**: as the data collector(s) fill in the table on the board, you will fill in the Criollo portion of the Abundant Resources data table on page 1 of the handout.
12. Have students calculate the total resources consumed, the percent of resources consumed, the mean resources per cow, and the number of cows that needed supplemental feed, and enter them at the bottom of the Abundant Resources data tables on page 1 of the handout.
13. Ask students to examine these data to help them make predictions about what might happen in Scenario 2 when there is a food shortage.

Grazing Game – Scenario 2 (food shortage due to higher temperatures and variable precipitation)

1. Use the PowerPoint presentation to explain that we will play the game again but under the condition of limited resources.
   a. **Slide 14**: in Scenario 2, average global surface temperatures continue to increase. Because Earth is warming, climate change is expected to increase the length and severity of drought in many rangelands in the semiarid western United States. Drought and increased evaporation will result in reduced water for plants. Therefore, our cows in Scenario 2 will encounter fewer and smaller grasses.
   b. **Slide 15**: fill out the predictions

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box at the top of page 2 of the *Get Out and Graze* handout. Under limited resources conditions (half as many resources as Scenario 1), predict which cattle breed will need more supplemental feed because they will not collect enough food resources during the game, and then predict which breed will consume a greater percentage of the resources available.

c. **Slide 16**: we will assign new students to the roles of the two types of cattle so that as many people as possible get to participate [assign students to roles].
   i. Five students – Angus for scenario 2
   ii. Five students – Criollo for scenario 2

d. **Slide 17**: the Angus trial and the Criollo trial are played using the same rules as in Scenario 1 except that in these trials **there are only 25 food resources** scattered among the close grazing sites and **25 food resources** scattered among the **far** grazing sites.
   i. Angus may still travel only to the close grazing sites while Criollo may travel to either the close or the far grazing sites.
   ii. A cow may only collect THREE food resources at the close grazing sites and TWO at the far grazing sites.

2. If you are using a drawn table on the board, erase the data from scenario 1 and change the number of resources available to 25 and 50 in the bottom of the table, as shown on page 2 of the handout. If you are using a document camera, prepare to show the Limited Resources data tables on page 2 of the handout.
3. Repeat steps 1-11 from Scenario 1, this time with just 25 food resources instead of 50.
   a. **Slide 18**: as the data collector(s) fill in the table on the board, you will fill in the Angus portion of the Limited Resources data table on page 2 of the handout.
   b. **Slide 19**: using the rules and procedures explained before, the five **Criollo cows** will now play the game. Remember that Criollo will travel **further from water**, so they can go to either the **close grazing sites** or far grazing sites. They may collect TWO food resources from far grazing sites and THREE food resources from close grazing sites.
   c. **Slide 20**: as the data collector(s) fill in the table on the board, you will fill in the Criollo portion of the Limited Resources data table on page 2 of the handout.
4. Have students calculate the total resources consumed, the percent of resources consumed, the mean resources per cow, and the number of cows that needed supplemental feed, and enter them at the bottom of the Limited Resources data tables on page 2 of the handout.

Mapping

1. Have the location mapper(s) collect all 10 of the location map strips and put them into the correct order.
   a. **Slide 21**: the location mapper(s) will collect all 10 of the location map strips and put them in the correct order as shown here.
2. If you have a document camera, project the map so all students can examine it.
3. If you do not have a document camera or other way to project the results, have the location mapper(s) replicate the map on the board. The exact location of each dot is not important, but the relative number of blue and green dots in close vs. far grazing sites should be replicated as closely as possible given the amount of time left.
4. After students have examined the results from the game, show the figure from the paper by Peinetti et al. (2011).
   a. **Slide 22**: this figure is from a research paper. The researchers conducted a study on the movement of Angus and Criollo cows in relation to a water source, and the movement of cows is shown on these maps. Angus cows are represented by blue, and Criollo cows are represented by green. The dot at the bottom of the map shows the location of the water source. Did Angus cows tend to get as far away from the water source as Criollo? [Answer: no, because there are green marks that are further away from the water source in the map on the right. Remember, Criollo are well adapted for dry landscapes and are able to move further away from water to take advantage of food resources in more remote locations.]
5. Ask students: how closely does the movement pattern of cows in our game match the movement pattern of Angus and Criollo in this study?

Results and Conclusions

1. Optional: if time permits, conduct the *Histogram Extension Activity* with students at this time. It will take approximately 15 minutes. See the Extensions section below for instructions.
2. Ask students to use the data tables to answer the results and conclusions questions on pages 2 and 3 of the handout. Choose one of the methods below to answer and discuss the questions as time permits.
   a. Students can answer all of the questions on their own, and then you can lead a discussion of each of the questions.
   b. Students can answer the questions as a whole group. Lead students in a discussion of each question, and solicit answers from students.
   c. Organize students in small

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groups and have each group work on one or two questions. Have one student from each group report to the class by reading the question and summarizing their group's answer.

EXTENSIONS

1. **Histogram Extension Activity**:
   a. Pass out a *Histogram Extension Activity* handout to each student. It is preferable to print this handout single sided so that students can look at the pages side-by-side when creating their histograms.
   b. For questions 1 and 2 on page 1 of the handout, explain that students will look back at their data tables on pages 1 and 2 of the *Get Out and Graze* handout and summarize their results. In order to prepare to make histograms for all four trials, students will fill in these tables by grouping the number of cows by the number of resources that they consumed. Students will look at the number of resources consumed by each cattle breed under each scenario, and write the number of resources consumed **only once**. In other words, if two cows ate nine resources, for example, students will not record the number "9" twice; instead they will record the number "9" once in the number of resources column, and then record "2" for the number of cows. Please see tables 1 and 2 below for a complete example.

Table 1. Sample of student data from page 1 of the Get Out and Graze *handout.*

ANGUS	
COW	NUMBER OF RESOURCES
1	9
2	8
3	12
4	11
5	9
TOTAL	49

Table 2. Example of how to fill out the first table on page 1 of the Histogram Extension Activity handout given the sample data in table 1 above.

ANGUS	
NUMBER OF RESOURCES	NUMBER OF COWS
8	1
9	2
10	0
11	1
12	1

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c. On page 2, instruct students to use the data tables on page 1 to create histograms for all four of the trials (Scenario 1, Angus and Criollo trials and Scenario 2, Angus and Criollo trials). In this case, histograms will show the number of cows by the number of resources consumed.

i. Instruct students to answer the conclusions questions at the bottom of page 2. Answers will vary based on student data.

Other Extensions

2. Ask students to brainstorm about conditions that may lead to scarcer or more abundant resources, and have them adjust the numbers of food resources accordingly. Play the game again.
3. Ask students to predict what would happen if the game was played with more cows of each breed during each scenario. Play the game again with 7-10 cows instead of 5 in both trials of each scenario.

ADDITIONAL RESOURCES

Articles with background information about Raramuri Criollo cattle:

Anderson, DM, Estell, RE, Gonzalez, AL, Cibilis, AF, and Torell, LA. 2015. Criollo cattle: Heritage genetics for arid landscapes. Rangelands 37(2): 62-67. Accessed online 9 Mar 2017. <http://www.sciencedirect.com/science/article/pii/S0190052815000152>.

Peinetti, HR, Fredrickson, EL, Peters, DPC, Cibils, AF, Roacho-Estrada, JO, and Laliberte, AS. 2011. Foraging behavior of heritage versus recently introduced herbivores on desert landscapes of the American Southwest. Ecosphere 2(5): 1-14.

Spiegal, S., Estell, R., Cibils, A. F., James, D. K., Peinetti, R., Browning, D. M., Romig, K., and Gonzales, A. Seasonal divergence in foraging behavior of heritage and conventional cattle on a heterogeneous desert landscape. Rangeland Ecology & Management.

Website with helpful information about Raramuri Criollo cattle:

The Jornada Rangelands Research Programs. Criollo Cattle on The Jornada. Web. Accessed 9 Mar 2017. <https://southwestbeef.org/>.

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COMPARE AND CONTRAST
TWO TYPES OF CATTLE

Date _____

Name _____

CRIOLLO
(pronounced krē-ō-yō)

Bos taurus · 800 pounds · Bloodlines from Spain

ANGUS

Bos taurus · 1,100 pounds · Bloodlines from Europe

1. What two similarities do you notice between Criollo and Angus?

2. What two differences do you notice between Criollo and Angus (**besides color**)?

3. Make a prediction about how **differences** might affect foraging behavior of the two cattle types on a western rangeland.

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COMPARE AND CONTRAST
TWO TYPES OF CATTLE

ANSWER KEY

CRIOLLO
(pronounced krē-ō-yō)

Bos taurus · 800 pounds · Bloodlines from Spain

ANGUS

Bos taurus · 1,100 pounds · Bloodlines from Europe

1. What two similarities do you notice between Criollo and Angus?
   May include:
   They are the same species (or both cattle), they have all of the same main body parts

2. What two differences do you notice between Criollo and Angus (**besides color**)?
   May include:
   Criollo is much smaller/weighs much less, Criollo is skinnier/Angus is bulkier, Angus does not have horns, Criollo originated in Spain/Angus originated in Europe

3. Make a prediction about how **differences** might affect foraging behavior of the two cattle types on a western rangeland.
   Example:
   Because Criollo is smaller and may be better adapted to dry climates due to its bloodline, it may be better suited to foraging on a western rangeland where water may be scarce.

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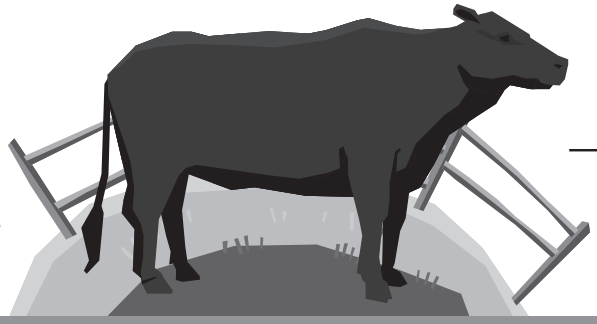
Name _____ Date _____

Criollo vs. Angus Cattle *in a Changing Climate*



GET OUT AND GRAZE (GO AG!)

Scenario 1 – Abundant Resources: Predictions

1. I predict that _____ cattle will need more supplemental feed because they will not collect enough food resources during the game.
   Angus / Criollo

2. I predict that _____ cattle will consume a greater percentage of the resources available.
   Angus / Criollo

Abundant Resources: Data

ANGUS	
COW	NUMBER OF RESOURCES
1	
2	
3	
4	
5	
TOTAL	

Total Number of Resources Available: 50

Percent of Total Resources Consumed:

(_____ ÷ 50) x 100 = _____%
Total

Mean Resources Per Cow:
(Total Resources Consumed divided by Number of Cows)

Number of Cows that Needed Supplemental Feed
(10 Resources or Less):

CRIOLLO	
COW	NUMBER OF RESOURCES
1	
2	
3	
4	
5	
TOTAL	

Total Number of Resources Available: 100

Percent of Total Resources Consumed:

(_____ ÷ 100) x 100 = _____%
Total

Mean Resources Per Cow:
(Total Resources Consumed divided by Number of Cows)

Number of Cows that Needed Supplemental Feed
(7 Resources or Less):

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Scenario 2 – Limited Resources: Predictions

1. I predict that _____ cattle will need more supplemental feed because they will not collect enough food resources during the game.
   Angus / Criollo

2. I predict that _____ cattle will consume a greater percentage of the resources available.
   Angus / Criollo

Limited Resources: Data

ANGUS	
COW	NUMBER OF RESOURCES
1	
2	
3	
4	
5	
TOTAL	

Total Number of Resources Available: 25

Percent of Total Resources Consumed:

(_____ ÷ 25) x 100 = _____%
Total

Mean Resources Per Cow:
(Total Resources Consumed divided by Number of Cows)

Number of Cows that Needed Supplemental Feed
(10 Resources or Less):

CRIOLLO	
COW	NUMBER OF RESOURCES
1	
2	
3	
4	
5	
TOTAL	

Total Number of Resources Available: 50

Percent of Total Resources Consumed:

(_____ ÷ 50) x 100 = _____%
Total

Mean Resources Per Cow:
(Total Resources Consumed divided by Number of Cows)

Number of Cows that Needed Supplemental Feed
(7 Resources or Less):

RESULTS AND CONCLUSIONS

1. Use the data tables on pages 1 and 2 to complete the following.

   a. The _____ cattle needed more supplemental feed because they did not collect enough food resources during the game.
      Angus / Criollo

   b. The _____ cattle consumed a higher percentage of the resources available.
      Angus / Criollo

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2. It is predicted in some places that climate change will cause increased temperatures and prolonged drought. This will reduce the availability of plants that cattle eat. Which type of cattle could better forage in these conditions? Why?

3. Increased temperatures and prolonged drought create a problem for cattle ranchers that rely on Angus cattle because they require more water and forage in a smaller area. Many ranchers are considering a transition to Criollo cattle.

   Identify two characteristics of Criollo that could make them a more sustainable alternative for cattle ranchers.

   -

   -

4. How would a transition to Criollo affect other parts of an ecosystem?

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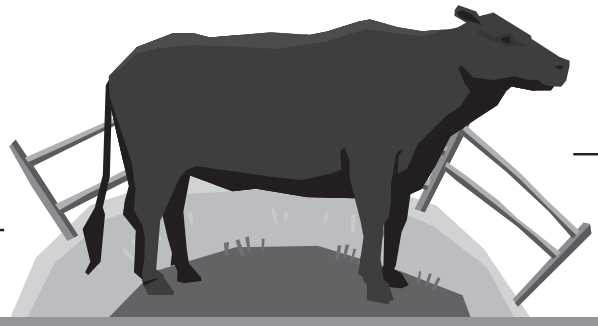
ANSWER KEY

Criollo vs. Angus Cattle *in a Changing Climate*



GET OUT AND GRAZE (GO AG!)

Scenario 1 – Abundant Resources: Predictions

1. I predict that _____ cattle will need more supplemental feed because they will not collect enough food resources during the
   Angus / Criollo

2. I predict that _____ cattle will consume a greater percentage of the resources available.
   Angus / Criollo

student answers will vary

Abundant Resources: Data

ANGUS	
COW	**NUMBER OF RESOURCES**
1	
2	
3	
4	
5	
TOTAL	

student answers will vary

Total Number of Resources Available: 50

Percent of Total Resources Consumed:

(_____ ÷ 50) x 100 = _____%
Total

Mean Resources Per Cow:
(Total Resources Consumed divided by Number of Cows)

Number of Cows that Needed Supplemental Feed
(10 Resources or Less):

CRIOLLO	
COW	**NUMBER OF RESOURCES**
1	
2	
3	
4	
5	
TOTAL	

student answers will vary

Total Number of Resources Available: 100

Percent of Total Resources Consumed:

(_____ ÷ 100) x 100 = _____%
Total

Mean Resources Per Cow:
(Total Resources Consumed divided by Number of Cows)

Number of Cows that Needed Supplemental Feed
(7 Resources or Less):

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Scenario 2 – Limited Resources: Predictions

1. I predict that _____ cattle will need more supplemental feed because they will not collect enough food resources during the game.
   Angus / Criollo

2. I predict that _____ will consume a greater percentage of the resources available.
   Angus / Criollo

student answers will vary

Limited Resources: Data

ANGUS	
COW	NUMBER OF RESOURCES
1	
2	
3	
4	
5	
TOTAL	

student answers will vary

Total Number of Resources Available: 25

Percent of Total Resources Consumed:

(_____ ÷ 25) x 100 = _____%
Total

Mean Resources Per Cow:
(Total Resources Consumed divided by Number of Cows)

Number of Cows that Needed Supplemental Feed
(10 Resources or Less):

CRIOLLO	
COW	NUMBER OF RESOURCES
1	
2	
3	
4	
5	
TOTAL	

student answers will vary

Total Number of Resources Available: 50

Percent of Total Resources Consumed:

(_____ ÷ 50) x 100 = _____%
Total

Mean Resources Per Cow:
(Total Resources Consumed divided by Number of Cows)

Number of Cows that Needed Supplemental Feed
(7 Resources or Less):

RESULTS AND CONCLUSIONS

1. Use the data tables on pages 1 and 2 to complete the following.

   a. The _____Angus_____ cattle needed more supplemental feed because they did not collect enough food resources during the game.
   Angus / Criollo

   This will usually be the case.

   b. The _____Angus_____ cattle consumed a higher percentage of the resources available.
   Angus / Criollo

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2. It is predicted in some places that climate change will cause increased temperatures and prolonged drought. This will reduce the availability of plants that cattle eat. Which type of cattle could better forage in these conditions? Why?

   Criollo may be better suited to forage in drought conditions because they are more likely to roam further away from a water source and search for food resources.

3. Increased temperatures and prolonged drought create a problem for cattle ranchers that rely on Angus cattle because they require more water and forage in a smaller area. Many ranchers are considering a transition to Criollo cattle.

   Identify two characteristics of Criollo that could make them a more sustainable alternative for cattle ranchers.

   - *Smaller, better adapted to move over difficult terrain*
   - *Able to move further from water source to forage*

4. How would a transition to Criollo affect other parts of an ecosystem?

   Criollo can spread their impact more widely over a grassland. They would be less likely to overgraze an area because their grazing would not be as concentrated. Therefore, plants would be more likely to survive and reproduce, and the effect of more abundant producers would likely be more abundant consumers.

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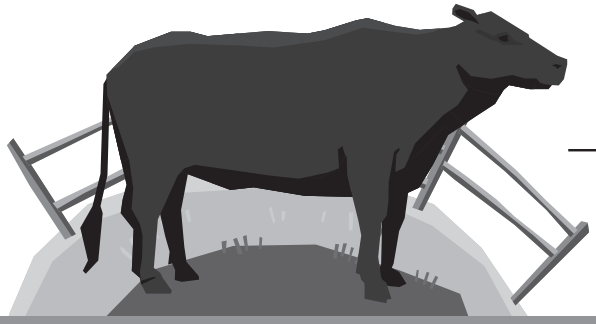
Name _____ Date _____

Criollo vs. Angus Cattle *in a Changing Climate*



GET OUT AND GRAZE (GO AG!)

HISTOGRAM EXTENSION ACTIVITY

1. Refer to page 1 of the *Get Out and Graze* handout. When resources were **abundant**, how many cows of each breed consumed each number of food resources? In other words, group the number of cows by the number of food resources they consumed. For example, if two cows consumed four food resources each, in the number of resources column, write "4" and in the number of cows column, write "2."

Abundant Resources

ANGUS	
NUMBER OF RESOURCES	NUMBER OF COWS

CRIOLLO	
NUMBER OF RESOURCES	NUMBER OF COWS

2. Refer to page 2 of the *Get Out and Graze* handout. When resources were **limited**, how many cows of each breed consumed each number of food resources?

Limited Resources

ANGUS	
NUMBER OF RESOURCES	NUMBER OF COWS

CRIOLLO	
NUMBER OF RESOURCES	NUMBER OF COWS

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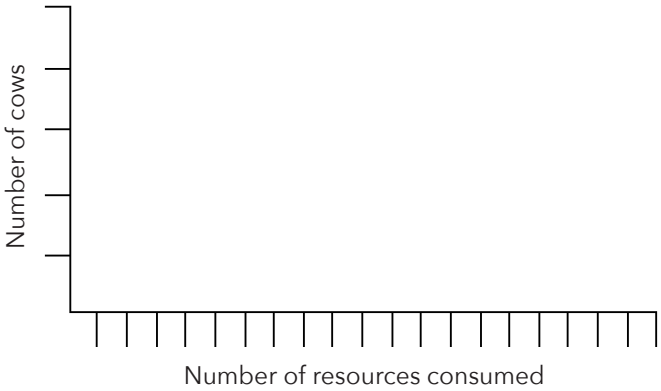
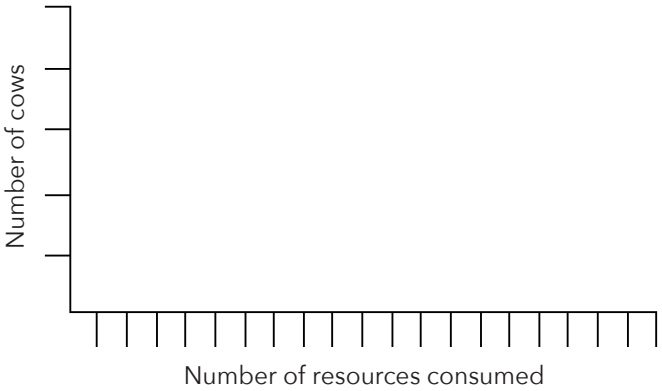
3. Use the data from questions 1 and 2 to create histograms, graphs of the number of cows by number of resources consumed.

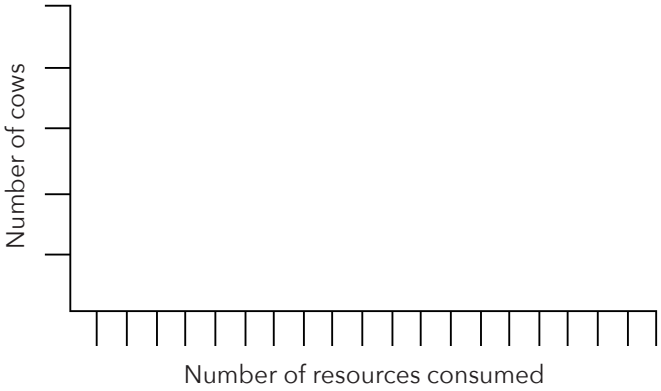
ANGUS
Abundant Resources



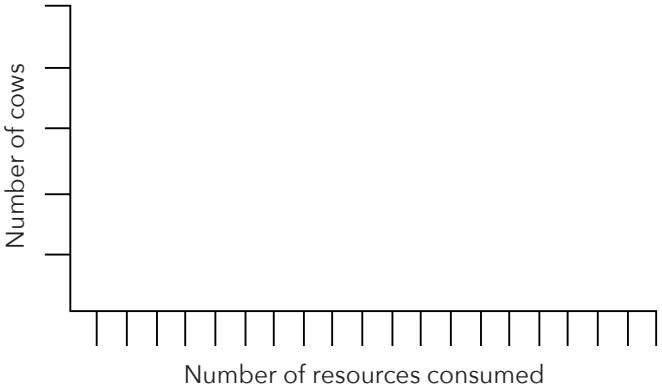
CRIOLLO
Abundant Resources



ANGUS
Limited Resources



CRIOLLO
Limited Resources



CONCLUSIONS

1. Describe similarities and differences in the way the data are distributed in the abundant resources and limited resources scenarios for **Angus cattle**. In other words compare and contrast how many **Angus** cows collected each number of resources in both scenarios.

2. Based on your answer to #1 above, in which scenario are Angus cattle less likely to need supplemental feed?

A. ABUNDANT RESOURCES **B. LIMITED RESOURCES**

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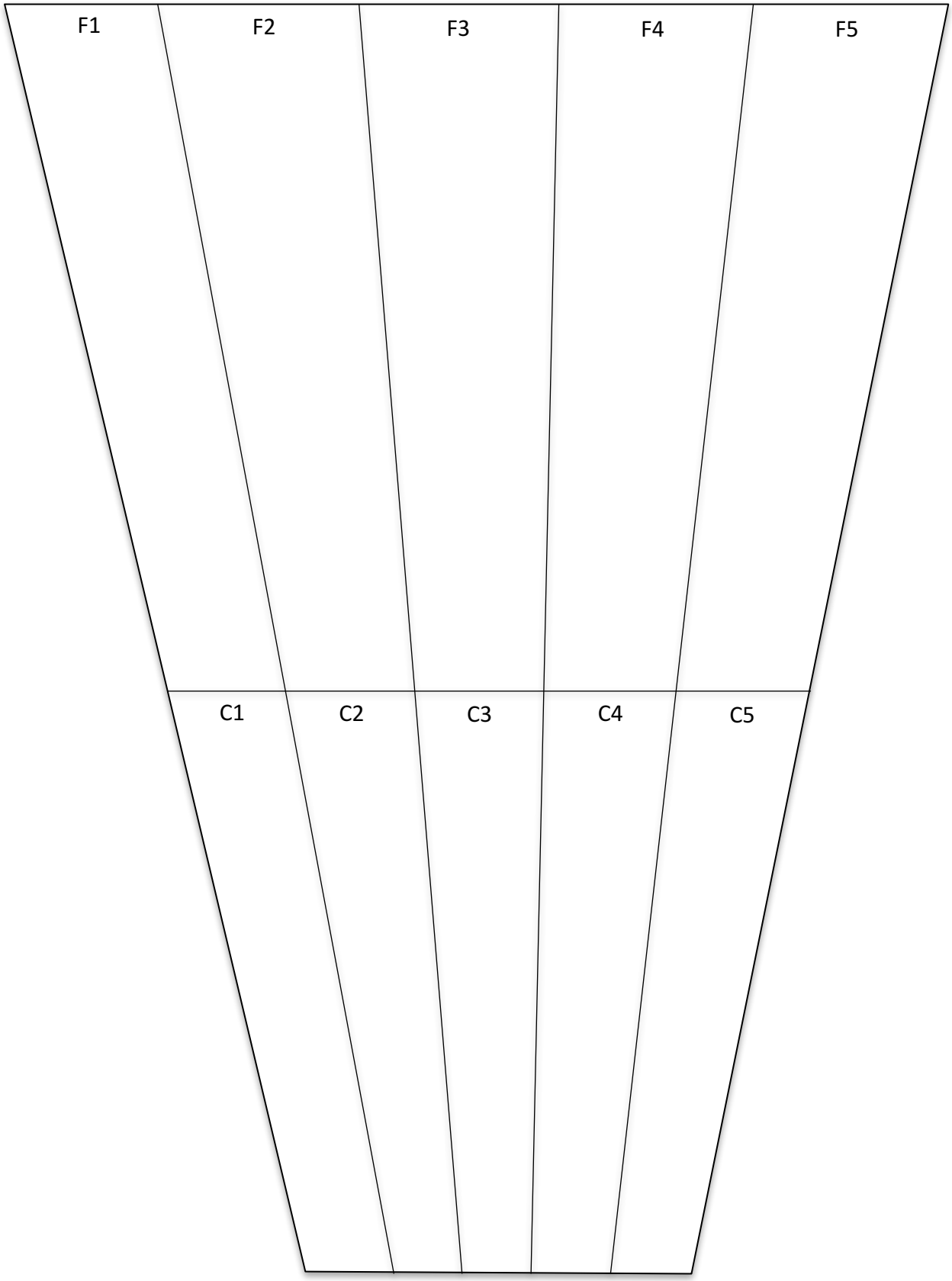
Close Grazing Site (Get 3 Food Packs)	**Far** Grazing Site (Get 2 Food Packs)
Close Grazing Site (Get 3 Food Packs)	**Far** Grazing Site (Get 2 Food Packs)

Note: make copies of this page. You will need five “Close” labels and five “Far” labels.

Location Map