Winning for Wildlife

Lesson #1

LESSON TOPIC:	What is the issue?
AIM:	Introduce students to the topic of wildlife crossings
OBJECTIVES:	Students will be able to: • view photos of wildlife using crossings at different times of day, animals on the road alive, and roadkill. While viewing photos, students record observations. • gather in a circle with a story posted by the public on the ARC website. Students read aloud and listen to each other's stories. • write a Claim and Evidence as part of a C-E-R sequence regarding this topic. They will add to the Evidence portion throughout the next few lessons.
DO-NOW: **(BELL WORK)**	1. Make observations photos provided in packet (see Appendix A for examples. More images/photos can be found by searching the internet). 2. Record observations in science notebook. 3. Discuss what students noticed. Make a class chart (t-chart) listing what students notice and what students wonder.
LESSON:	• Gather students in a circle and hand out anecdotal stories (these are from the ARC website – https://arc-solutions.org/road-stories/ • Ask for volunteers to read each story, discussing students impressions/thoughts after each story.
CLOSING:	Ask students to write a Claim and Evidence – just using what was presented in today's lesson (photos and stories) regarding wildlife crossings. Ask them to write this in their science notebook, as they will add to the evidence and finish the 'R' (Reasoning) portion of the C-E-R at the end of the unit. For more information about C-E-R, watch https://www.youtube.com/watch?v=5KKsLuRPsvU
ASSESSMENT:	Formative observation by teacher
MODIFICATIONS:	Teachers may want to provide a template for students to use to write their C-E-R, depending on student experience with this practice (see Appendix C).
FOCUS CCSS/NGSS Practices:	NGSS Practice 1 Asking Questions and Defining Problems NGSS Practice 4 Analyzing and Interpreting Data NGSS Practice 8 Obtaining, Evaluating, and Communicating Information
MATERIALS:	• Photos of animals using crossings • Anecdotal stories from ARC website • C-E-R template
TECHNOLOGY:	Possible teacher presentation of photos for discussion purposes.

Winning for Wildlife

Lesson #2

LESSON TOPIC:	Where are the animals?
AIM:	Get students looking for where the animals are located/crossing the roads.
OBJECTIVES:	Students will be able to: • discuss how decision-makers make decisions about where and if a crossing is needed. • collect data for a period of 2 weeks. Decisions are made to collect data on living and dead animals seen near roadways and specifics of locations. *Use GPS if available. • place stickers on map of area. Each color sticker represents different type of animal.
DO-NOW: **(BELL WORK)**	1. Discuss who are the decision-makers in our society. Students pair-share and then whole group share their thoughts. 2. Discuss how decision-makers make decisions, such as where they might build a wildlife crossing or place an animal crossing sign. Students pair-share and then whole group share their thoughts.
LESSON:	1. Teach students how to read a map of their local area (teachers need to find own local maps for this purpose). 2. Decide on a way to collect data on where/what/when animals are observed in various areas. 3. Over the course of a 1 – 2 week period of time, invite students to indicate on class map, using stickers perhaps, where animals were observed (see Appendix B for example).
CLOSING:	At the conclusion of the study period, ask students to use the data they collected to make decisions regarding a placement of a wildlife crossing sign or a possible wildlife crossing. Discuss the importance of using data to make decisions.
ASSESSMENT:	Formative observation by teacher Data collection instrument as determined by class Add evidence to C-E-R instrument started in lesson 1.
MODIFICATIONS:	If GPS devices are available, have students record the latitude and longitude where the animals were observed.
FOCUS CCSS/NGSS Practices:	NGSS Practice 1 Asking Questions and Defining Problems NGSS Practice 3 Planning and Carrying Out Investigations NGSS Practice 4 Analyzing and Interpreting Data NGSS Practice 6 Constructing Explanations and Designing Solutions NGSS Practice 8 Obtaining, Evaluating, and Communicating Information
MATERIALS:	• Map of local area

TECHNOLOGY:	Possible use of GPS technology if available.

Winning for Wildlife

Lesson #3

LESSON TOPIC:	What else do we need to know?
AIM:	Students read a scientific journal article about the topic of wildlife crossings in order to gain greater schema around the issue.
OBJECTIVES:	Students will be able to: • read a scientific journal article in order to gain background schema around this issue • practice annotations of close-reading practices
DO-NOW: (BELL WORK)	1. Have students take out highlighters or any other tools they've used in the past for annotation of a text. 2. Review annotation guidelines for close reading.
LESSON:	1. Read the article alone (students alone). 2. Direct the students to read the article a second time, this time annotating for meaning, making specific notes on questions they have about the topic. 3. After students have had a chance to read a second time, read the article a third time as a class, this time discussing each paragraph and creating a chart of student questions.
CLOSING:	See Appendix C for example of what this might look like in the classroom.
ASSESSMENT:	Formative observation by teacher Data collection instrument as determined by class Add evidence to C-E-R instrument started in lesson 1.
MODIFICATIONS:	Scaffolded or teacher-led reading for EL students.
FOCUS CCSS/NGSS Practices:	NGSS Practice 1 Asking Questions and Defining Problems NGSS Practice 3 Planning and Carrying Out Investigations NGSS Practice 4 Analyzing and Interpreting Data NGSS Practice 6 Constructing Explanations and Designing Solutions NGSS Practice 8 Obtaining, Evaluating, and Communicating Information
MATERIALS:	https://westerntransportationinstitute.org/research_projects/us-93-post-construction-wildlife-vehicle-collision-and-wildlife-crossing-monitoring-research/ There are several articles on this website. Choose an article around this issue that is most appropriate for your level of students.
TECHNOLOGY:	There are many podcasts around this topic. One that was interesting for students to listen to is this one regarding Citizen Science connections with a roadkill documentation App. https://www.npr.org/sections/thetwo-way/2014/06/05/319244171/tracking-road-kill-theres-an-app-for-that-too

Winning for Wildlife

Lesson #4

LESSON TOPIC:	Examples of success
AIM:	Path of the Pronghorn
OBJECTIVES:	Students will be able to: • identify successful solutions to the problem of animal and vehicle collisions • discuss what makes a solution viable and probable
DO-NOW: **(BELL WORK)**	1. Hand out color copies of the "Path of the Pronghorn" map while discussing with students the area and solution they are about to watch (via the video). Read the text (see materials list below) to get students engaged on the topic.
LESSON:	1. Watch the "Path of the Pronghorn" video. 2. Discuss what made the solution a success. 3. Discuss what made the Pronghorn a candidate for such a successful implementation of an animal road crossing structure.
CLOSING:	Students as teachers. Students teach others about this particular success story and discuss lessons learned.
ASSESSMENT:	Formative observation by teacher Data collection instrument as determined by class Add evidence to C-E-R instrument started in lesson 1.
MODIFICATIONS:	If GPS devices are available, have students record the latitude and longitude where the animals were observed.
FOCUS CCSS/NGSS Practices:	NGSS Practice 1 Asking Questions and Defining Problems NGSS Practice 3 Planning and Carrying Out Investigations NGSS Practice 4 Analyzing and Interpreting Data NGSS Practice 6 Constructing Explanations and Designing Solutions NGSS Practice 8 Obtaining, Evaluating, and Communicating Information
MATERIALS:	https://northamerica.wcs.org/wild-places/yellowstone-and-northern-rockies/pronghorn-field-program/pronghorn-migration-path.aspx Reading and video located at this website
TECHNOLOGY:	Ability to display video for class

Winning for Wildlife

Lesson #5

LESSON TOPIC:	What does the data tell us?
AIM:	Use data analysis strategies to make compelling statements, using mathematics, in order to bring awareness to the issue
OBJECTIVES:	Students will be able to: • analyze tables of data regarding animal/vehicle collisions • analyze graphs of data regarding animal/vehicle collisions • calculate percentages, rates, and other mathematical comparison statements for the purpose of sharing data with others in more understandable ways
DO-NOW: **(BELL WORK)**	1. Choose one graph or table to display for the entire class. Ask students to Think Pair Share with their table/elbow partner regarding something they notice and something they wonder about the data. 2. Discuss how to use the math skills students are familiar with to make this data more understandable to others. 3. As a class, create a single statement, using any piece of data as an example of writing compelling statements about this issue.
LESSON:	1. Spread out multiple copies of the data tables and graphs you have available so there are many for students to access. 2. Have calculators available for students as well and allow them to work together to make statements that mean something to them. 3. Give students plenty of time to "play with" the data in order to find ways to use the data in appropriate yet meaningful ways.
CLOSING:	Share statements with the entire class and write them on a large class chart for use in final project (brochure) lesson/activity. See Appendix E for an example of how this might look in the classroom.
ASSESSMENT:	Formative observation by teacher Data collection instrument as determined by class Add evidence to C-E-R instrument started in lesson 1.
MODIFICATIONS:	If GPS devices are available, have students record the latitude and longitude where the animals were observed.
FOCUS CCSS/NGSS Practices:	NGSS Practice 1 Asking Questions and Defining Problems NGSS Practice 3 Planning and Carrying Out Investigations NGSS Practice 4 Analyzing and Interpreting Data NGSS Practice 5 Using mathematics and computational thinking NGSS Practice 6 Constructing Explanations and Designing Solutions NGSS Practice 7 Engaging in argument from evidence NGSS Practice 8 Obtaining, Evaluating, and Communicating Information
MATERIALS:	Multiple copies of data tables, graphs, etc. around this topic. Teachers will need to choose what is most appropriate for their group of students. See Appendix E for examples of what this might look like in the classroom.

TECHNOLOGY:	Calculators

Winning for Wildlife

Lesson #6

LESSON TOPIC:	Population Sampling
AIM:	Investigate the mathematics behind this common wildlife sampling technique
OBJECTIVES:	Students will be able to: • apply mark/recapture technique to a population of "beans" in order to use proportional reasoning techniques to determine population size
DO-NOW: **(BELL WORK)**	1. Discuss how scientists count animal populations. 2. Discuss problems with counting animal populations in general and also for specific types of animals.
LESSON:	1. Tell students that they are going to practice population sampling using a technique called mark-recapture. Explain the procedure of mark-recapture and model it for students to begin with. 2. Hand out materials (see Appendix F for a lesson plan using squirrels as the context for the mark/recapture). Teachers can choose any subject that makes logical sense to use as the context. This lesson plan serves as an example for teachers to work from to create something that fits their own situation. 3. See Appendix G for what this might look like in your classroom in terms of setup and material use.
CLOSING:	Have students discuss populations of other animals that may benefit scientists by using this type of population sampling technique.
ASSESSMENT:	Formative observation by teacher Data collection instrument as determined by class Add evidence to C-E-R instrument started in lesson 1.
MODIFICATIONS:	If GPS devices are available, have students record the latitude and longitude where the animals were observed.
FOCUS CCSS/NGSS Practices:	NGSS Practice 1 Asking Questions and Defining Problems NGSS Practice 3 Planning and Carrying Out Investigations NGSS Practice 4 Analyzing and Interpreting Data NGSS Practice 5 Using mathematics and computational thinking NGSS Practice 6 Constructing Explanations and Designing Solutions NGSS Practice 8 Obtaining, Evaluating, and Communicating Information
MATERIALS:	beans, calculators, markers
TECHNOLOGY:	Watch a video of scientists using this type of sampling in the field. For example: https://www.youtube.com/watch?v=ekSjRsnhJrk

Winning for Wildlife

Lesson #7

LESSON TOPIC:	Communicate to others
AIM:	Students will create a brochure with the purpose of educating others on the topic of wildlife-vehicle collisions
OBJECTIVES:	Students will be able to: • use all their information gained throughout the past 6 lessons to create a brochure • communicate the topic in an easy-to-read format for the purpose of educating others
DO-NOW: **(BELL WORK)**	1. Hand out a collection of brochures from places or businesses around your town (unrelated to the topic of wildlife/vehicle collisions). 2. Ask students to make a list, with a partner, of all the features of a brochure, making special note of the most effective features.
LESSON:	1. Display the Brochure Grading Rubric (Appendix I) and discuss expectations. 2. Encourage students to use the math statements they wrote in the previous lessons as compelling points to make in their brochures. 3. Explain the audience for the brochure (other students) and the timeline.
CLOSING:	To see examples of what this might look like, see Appendix H.
ASSESSMENT:	Formative observation by teacher Data collection instrument as determined by class Add evidence to C-E-R instrument started in lesson 1.
MODIFICATIONS:	Allowing students to work together with a small group
FOCUS CCSS/NGSS Practices:	NGSS Practice 1 Asking Questions and Defining Problems NGSS Practice 3 Planning and Carrying Out Investigations NGSS Practice 4 Analyzing and Interpreting Data NGSS Practice 5 Using mathematics and computational thinking NGSS Practice 6 Constructing Explanations and Designing Solutions NGSS Practice 8 Obtaining, Evaluating, and Communicating Information
MATERIALS:	Paper, art supplies, calculators, computers
TECHNOLOGY:	Possible access to internet

Winning for Wildlife

Lesson #8

LESSON TOPIC:	Wildlife Crossing Design Contest
AIM:	Students will design a mini-version of a wildlife crossing over an imagined highway
OBJECTIVES:	Students will be able to: • work together to design a protype of a wildlife crossing structure of their choice
DO-NOW: **(BELL WORK)**	Show students the video from the ARC Design Contest. https://vimeo.com/18856922 for student idea generating and motivation.
LESSON:	1. Introduce to students the idea of using our data (collected on the map of our area in lesson 2) to determine where a wildlife crossing would be beneficial. Reach consensus with the class regarding the "placement" of the structure. 2. Challenge students to design a structure, in groups, and create a blueprint of what they'd like their structure to look like. 3. Determine a location for their structures to be built and explain guidelines/time limit for their building. 4. Celebrate their accomplishment and all they learned throughout the "Winning for Wildlife" module
CLOSING:	Student "gallery walk" and presentation of structures along the trail. See Appendix J for examples of what this might look like in your classroom.
ASSESSMENT:	Formative observation by teacher Data collection instrument as determined by class Complete the -R- portion of the C-E-R for final assessment criteria.
MODIFICATIONS:	Teacher discretion / see student accommodations list
FOCUS CCSS/NGSS Practices:	NGSS Practice 1 Asking Questions and Defining Problems NGSS Practice 3 Planning and Carrying Out Investigations NGSS Practice 6 Constructing Explanations and Designing Solutions NGSS Practice 8 Obtaining, Evaluating, and Communicating Information
MATERIALS:	https://vimeo.com/18856922
TECHNOLOGY:	Ability to show the video to the entire class

Appendix A

Appendix A

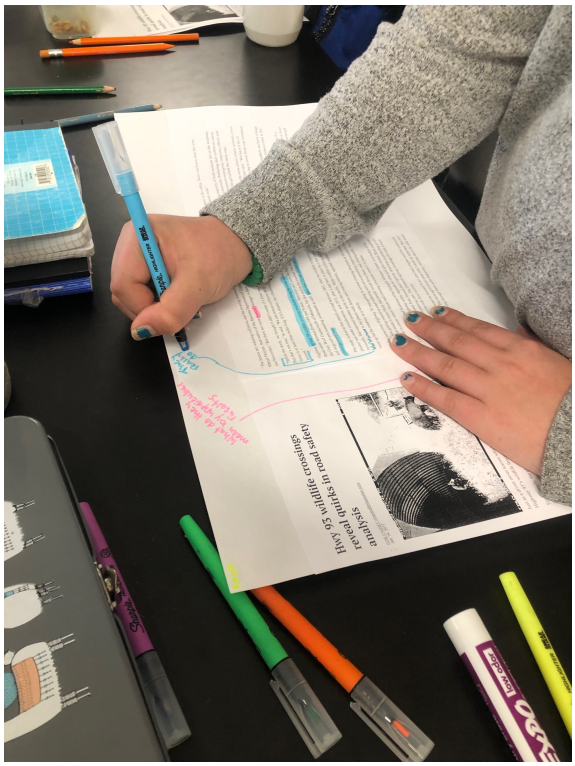
Appendix A

Bobcat and kit

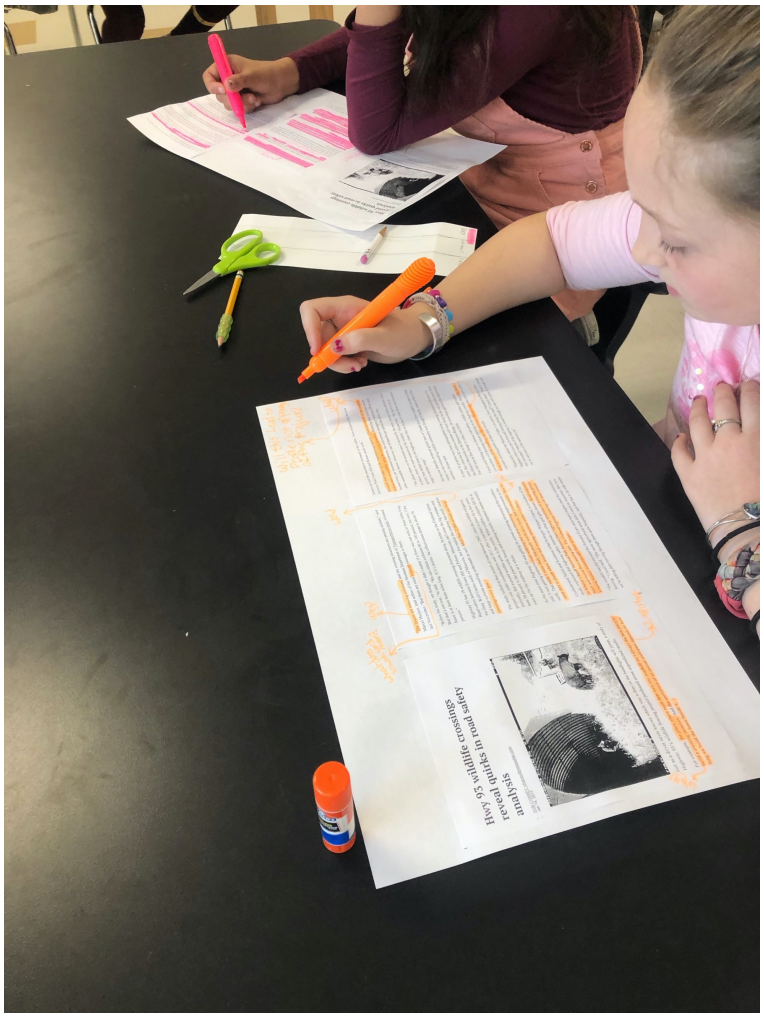
Courtesy of: CSKT, MDT, & WTI-MSU

Appendix B

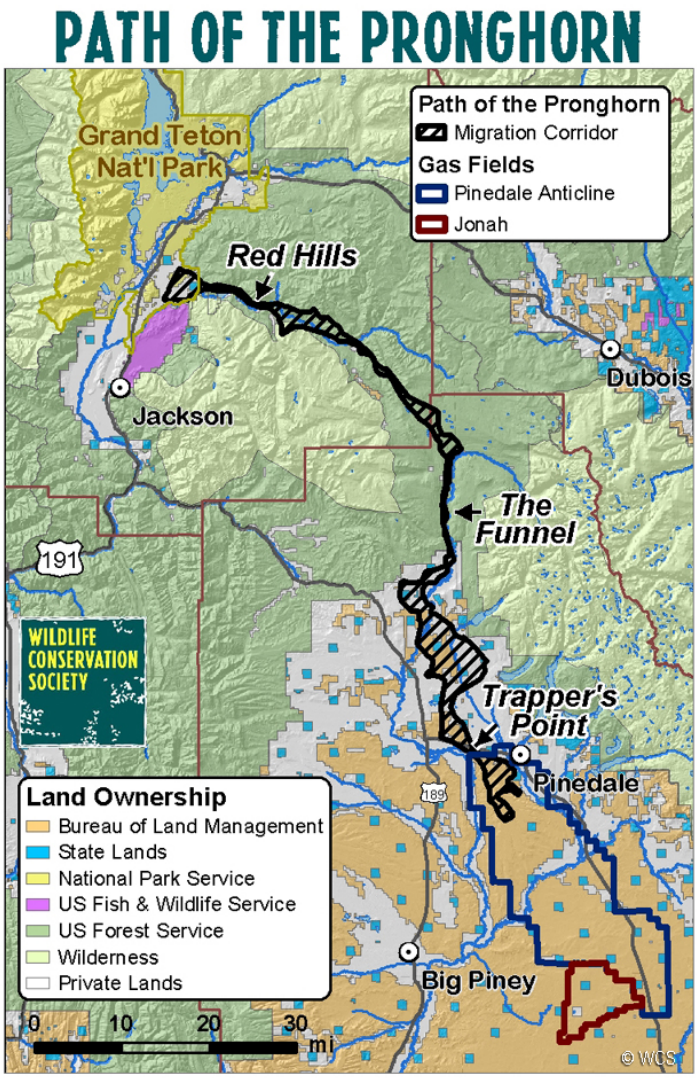
Appendix C


Hwy 23 Wildlife crossings
Crewel Quirks In road safety
analysis
Link to Jurassic
model of Wildlife
Crossings
Link
Back

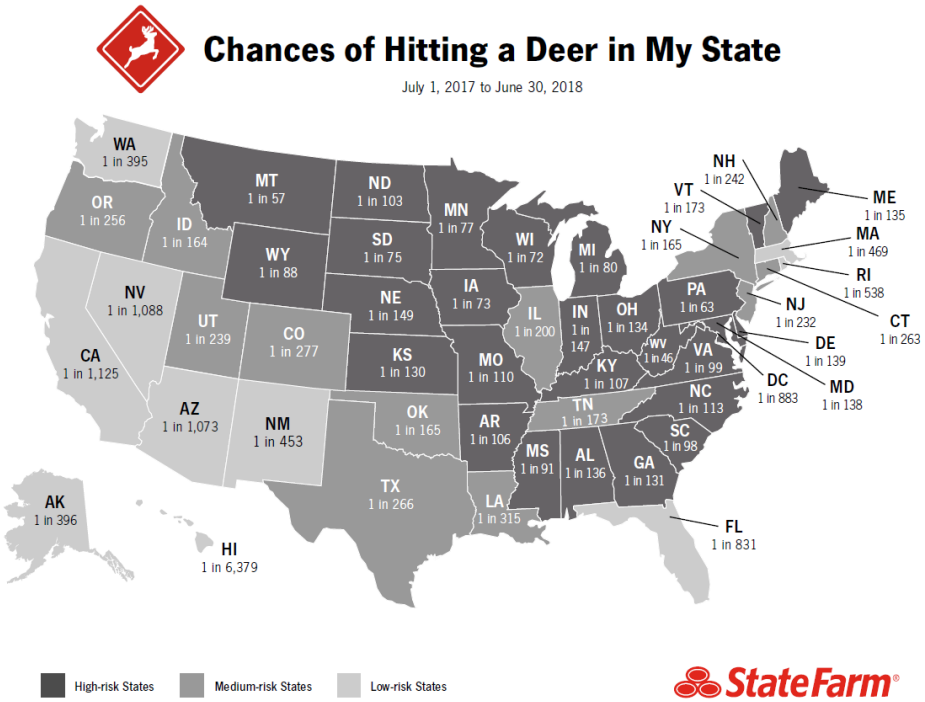
Appendix C


How 95 wildlife crossings
revived quokkas in road safety
analysis

Appendix D

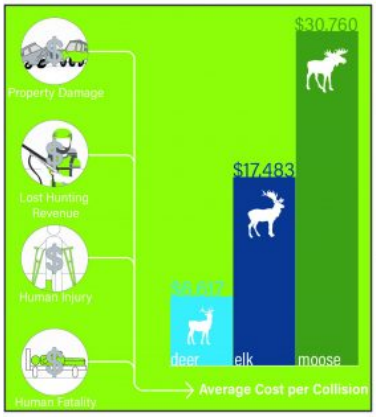

PATH OF THE PRONGHORN
Path of the Pronghorn
Migration Corridor
Gas Fields
Pinedale Anticline
Jonah
Grand Teton Nat'l Park
Red Hills
Jackson
Dubois
The Funnel
191
WILDLIFE CONSERVATION SOCIETY
Trapper's Point
Pinedale
189
Big Piney
Land Ownership
Bureau of Land Management
State Lands
National Park Service
US Fish & Wildlife Service
US Forest Service
Wilderness
Private Lands
0 10 20 30 mi
© WCS

Appendix E


Chances of Hitting a Deer in My State
July 1, 2017 to June 30, 2018
WA 1 in 395
OR 1 in 256
ID 1 in 164
MT 1 in 57
ND 1 in 103
MN 1 in 77
SD 1 in 75
WY 1 in 88
WI 1 in 72
MI 1 in 80
NV 1 in 1,088
UT 1 in 239
CO 1 in 277
NE 1 in 149
IA 1 in 73
IL 1 in 200
IN 1 in 147
OH 1 in 134
PA 1 in 63
NY 1 in 165
VT 1 in 173
NH 1 in 242
ME 1 in 135
MA 1 in 469
RI 1 in 538
CT 1 in 263
NJ 1 in 232
DE 1 in 139
MD 1 in 138
DC 1 in 883
VA 1 in 99
WV 1 in 46
KY 1 in 107
CA 1 in 1,125
AZ 1 in 1,073
NM 1 in 453
KS 1 in 130
MO 1 in 110
OK 1 in 165
AR 1 in 106
TN 1 in 173
NC 1 in 113
SC 1 in 98
MS 1 in 91
AL 1 in 136
GA 1 in 131
TX 1 in 266
LA 1 in 315
FL 1 in 831
AK 1 in 396
HI 1 in 6,379
High-risk States
Medium-risk States
Low-risk States
StateFarm

Appendix E

	United States
Animal-Vehicle Collisions	1-2 million (mostly deer)
Human Injuries	29,000
Human Fatalities	211
Property Damage	6-12 billion USD $

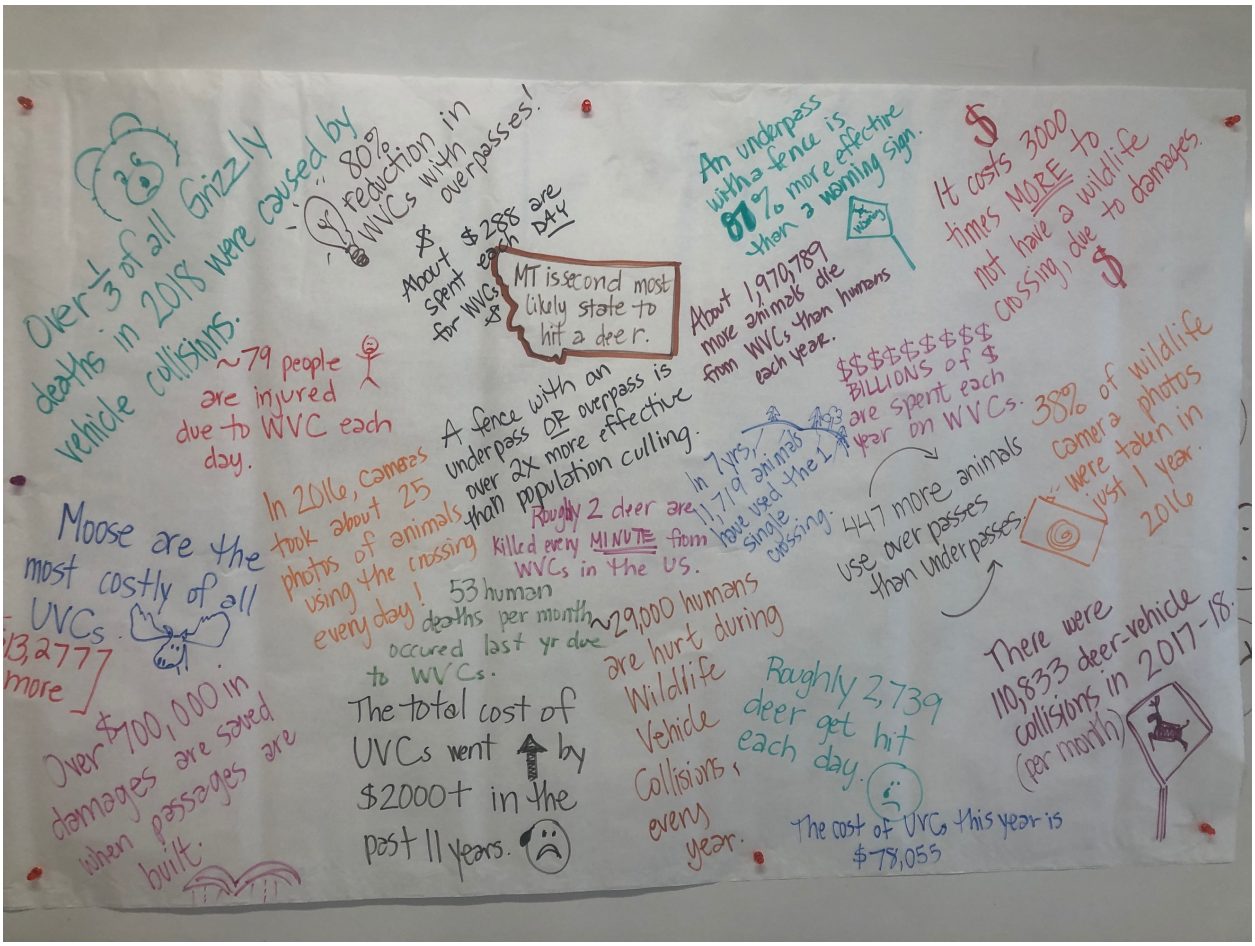


DESCRIPTION	DEER	ELK	MOOSE
TOTAL COSTS PER COLLISION (2007)	$6,617	$17,483	$30,760
TOTAL COSTS PER COLLISION (2018)	$8,190	$25,319	$44,546

Species	Pre-Construction WVCs 1998-2003	Cost of UVCs*	Post-Construction WVCs 2005-2010	Cost of UVCs*
Deer	30	$198,510	8	52,936
Elk	22	$384,626	3	52,449
Moose	5	$153,800	0	0
Bighorn Sheep	5	$33,085	0	0
Coyote	5	$0	0	0
Wolf	2	$0	0	0
Cougar	1	$0	0	0
Black Bear	0	$0	2	0
Beaver	0	$0	2	0
Unknown	1	$0	0	0
Total WVCs and Costs of the UVCs	71	$770,021	15	$105,385
Annual WVC Rates and Costs	11.8	$128,337	2.5	$17,564

* Ungulate (Large Mammal) Vehicular Crossing

Appendix E


Over 1/3 of all Grizzly deaths in 2018 were caused by vehicle collisions.
80% reduction in WVCs with overpasses!
$ About $288 are spent each DAY for WVCs $
MT is second most likely state to hit a deer.
An underpass with a fence is 87% more effective than a warning sign.
$ It costs 3000 times MORE to not have a wildlife crossing, due to damages. $
About 1,970,789 more animals die from WVCs than humans each year.
~79 people are injured due to WVC each day.
A fence with an underpass OR overpass is over 2x more effective than population culling.
$$$$$$$$$$ BILLIONS of $ are spent each year on WVCs.
In 2016, cameras took about 25 photos of animals using the crossing every day!
Roughly 2 deer are killed every MINUTE from WVCs in the US.
In 7yrs, 11,719 animals have used the 1 single crossing.
447 more animals use over passes than underpasses.
38% of wildlife camera photos were taken in just 1 year. 2016
Moose are the most costly of all UVCs. $3,277 more
53 human deaths per month occured last yr due to WVCs.
~29,000 humans are hurt during Wildlife Vehicle Collisions, every year.
Over $700,000 in damages are saved when passages are built.
The total cost of UVCs went by $2000+ in the past 11 years.
Roughly 2,739 deer get hit each day.
There were 110,833 deer-vehicle collisions in 2017-18. (per month)
The cost of UVCs this year is $78,055

Capture-Recapture Lesson Plan (Grades 6-8)

Objectives:

- Recognize equivalent ratios
- Determine good and poor estimates
- Solve proportions to estimate population size

Materials*:

- Estimating Population Size Activity Sheet
- Black Marker
- 64 Flying Squirrels per group (can be found under sources)
- 32 Squirrels per group (can be found under sources)
- 2 Sheets of Printer Paper per group
- Ziploc bag or cup for holding paper cut-outs
- Circle (Cut Out) per group (can be found under sources)
- Top to Printer Paper Box

*See "Alternate Materials" at the end of lesson plan for additional ideas for manipulatives.

Before Class Preparation by Teacher:

(For Activity 1) Before class starts, put about 30 post-it notes on the walls around the classroom. This is to simulate a population in its natural habitat. It is a good idea to put up enough post-it notes so that it is a little difficult for students to count without losing track, but not so many that this activity takes a long time. Also, in order for the students to understand the difficulty of just counting the population by sight, make sure to hide 6-8 post-it notes in areas students may not think to look, for instance, under a couple of student's' desks or in a hidden corner. It is important that the students do not find all the post-it notes on the first look search.

(For Activity 2) Before beginning this activity, for each group prepare 64 flying cartoon squirrels, 32 regular squirrels, and two sheets of printer paper cut up into squares of almost equal sizes. The flying squirrels will simulate actual flying squirrels in their natural habitat, and the cut up blank sheets of paper represent vegetation in the natural habitat that would block a field ecologist's field of vision to make counting difficult. The regular squirrels represent another species in the habitat that is not endangered, that might end up in the trap with the species of interest. Put the cut out flying squirrels, regular squirrels and vegetation squares into a ziplock bag or cup. It is important that the students do not know the number of flying squirrels at the beginning of the activity. The inside of the printer paper box top needs to be separated into 9

equal rectangular sampling regions. Then, the annulus needs to be cut with a hole in the middle to be the trap. This circle will become the trap. Finally, there needs to be a worksheet for every member of the group.

Instruction Plan:

Introduction:

Begin class talking about endangered species. In Tennessee, there are four endangered bird species, twenty endangered fish species, three endangered mammal species, three endangered snail species, and thirty-nine endangered mussel species. With endangered species, field ecologists want to keep an accurate account of how many are left in a population. Discuss with the class: "What do you think some of the problems are with keeping accurate data on endangered species?" One of the mammals endangered in Tennessee is the Carolina Northern Flying Squirrel. Ask the class, "What do you know about this animal? What do you think are some of the specific problems field ecologists have with keeping accurate population data on this mammal?" Tell the students today they are going to try different methods field ecologists might use to study animal populations. The students will focus on the flying squirrel.

Activity 1: How many can you count?

Once class begins, ask for two volunteers. Let the students know that there is a wild population of flying squirrels (post-it notes) in the classroom. It is up to the two volunteers to count all of the flying squirrels with help from their classmates in their seats. They should each start in a different spot and count independently of each other, but with help from their classmates. After the two volunteers count all the post-it notes they can see, ask the two students for their totals and record them on the board. If the totals are different, you can discuss why that might have happened. Ask the whole class if they agree with the total (s). After they agree, tell students that they forgot that animals hide! Tell students to look under their desks or anywhere else that you hid the post-it notes. When all the post-it notes have been located, tell the students this is a problem many field ecologists go through when trying to find all the animals in a population, because animals like to hide. Tell students to imagine how much more difficult it would be if the animals were also moving around.

Activity 2: Estimating Population Size:

To begin this activity, tell students they will be field ecologists today running through a simulation to count the flying squirrels are in their habitat. First, students need to take the bag of paper cut-outs and spread them throughout the regions. Make sure the students have an approximately even distribution of the cut-outs throughout the habitat. Explain that the students

will be using two different methods to estimate the population size. Their habitat has been divided into equal portions, called sampling regions, which will help ensure that the sampling is random and unbiased.

For the first method, students will count the flying squirrels that are trapped in sample regions, and then estimate the total number of flying squirrels in the entire habitat. In order to begin, the the teacher should choose four numbers at random to correspond with the regions the students should sample. The teacher writes these region numbers on the board. Students then record the the region numbers in the left-side of the table. Then, students trap in those regions. Demonstrate "trapping" for the students. Have them place their trap down somewhere in the selected region. Then, they should scoop up all of the squirrels (flying and regular) and vegetation that are within the trap's boundary. Students then separate, count and record the flying squirrels that they have scooped out. Then, this is repeated in the next region. Tell students to make sure they do not put their trapped squirrels and vegetation back into the habitat until they are done counting in all four selected regions. Students then follow the directions on the worksheet to finish the estimate of the flying squirrel population, and have each group complete the questions. After the students have completed the first method, record on the board each group's total and discuss the two questions. Point out and discuss differences in the estimates that were found by different groups.

For the second method, the students will be using a common field ecology practice of mark and recapture. Again, four random region numbers need to be selected by the teacher. The students will again trap in the four regions and separate the flying squirrels from the vegetation and the regular squirrels. Make sure they do not reintroduce the materials back into the habitat until they have recorded all of the flying squirrels from the four regions. After they have recorded the amount of flying squirrels they have captured, the students need to mark the squirrels (only the flying ones!) by using a marker and placing a dot on their captured animals. Once they are done marking, they need to reintroduce the material into the habitat. Again, four random region numbers need to be selected to trap. The students need to trap and separate the flying squirrels from the other material. Then, the students need to separate them into marked and unmarked and record the data. The students will use equivalent ratios to make the flying squirrel population estimate.

After the groups have had enough time to discuss and complete their calculations, they need to report their estimates from method 2. After the teacher records the data on the board, the groups can complete the questions. Once they have been completed, the class may come together for discussion of the questions. At the end of class, you can let the students know that there were 64 flying squirrels in their habitats. Or you can keep it a secret and make the point that in the field, there is no way to ever really know! You must instead trust your mathematical modeling.

Assessment and Extension:

Assessment:
Ask students to solve a comparable question:
Jake wants to know how many students from his school were at the soccer match and saw him score a goal. He knows that there are 850 students at his school. At lunch, he randomly asked 35 students if they had seen the game, and 3 of them said that they had.

- How can you use this information to estimate how many student from his school were at the game? Estimate how many students were there, and show your work.
- How confident are you that your estimate is close to the actual number of students who were at the game?
- What suggestions do you have for Jake to make sure that the estimate is close to the actual number of students that saw the game? [Take a few more samples to see what the range of estimates is or take a larger sample and compare the results.]

Extensions:

1. What if one field ecologist marks the birds with a blue label, and another field ecologist uses a red label. What effect does this have on the way they recapture and use the data? Simulate this using a second marker to mark the beans with another colored pen.
2. Have students write up different scenarios where capture-recapture would be applicable.
3. If the students have time to count the total number of flying squirrels, ask them to calculate the percent of error between their guessed population size and actual population size.

TN Math Standards:

6th Grade:
Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

7th Grade:
Use proportional relationships to solve multistep ratio and percent problems.

Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.

Use data from a random sample to draw inferences about the population with an unknown characteristics of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions.

Sources:

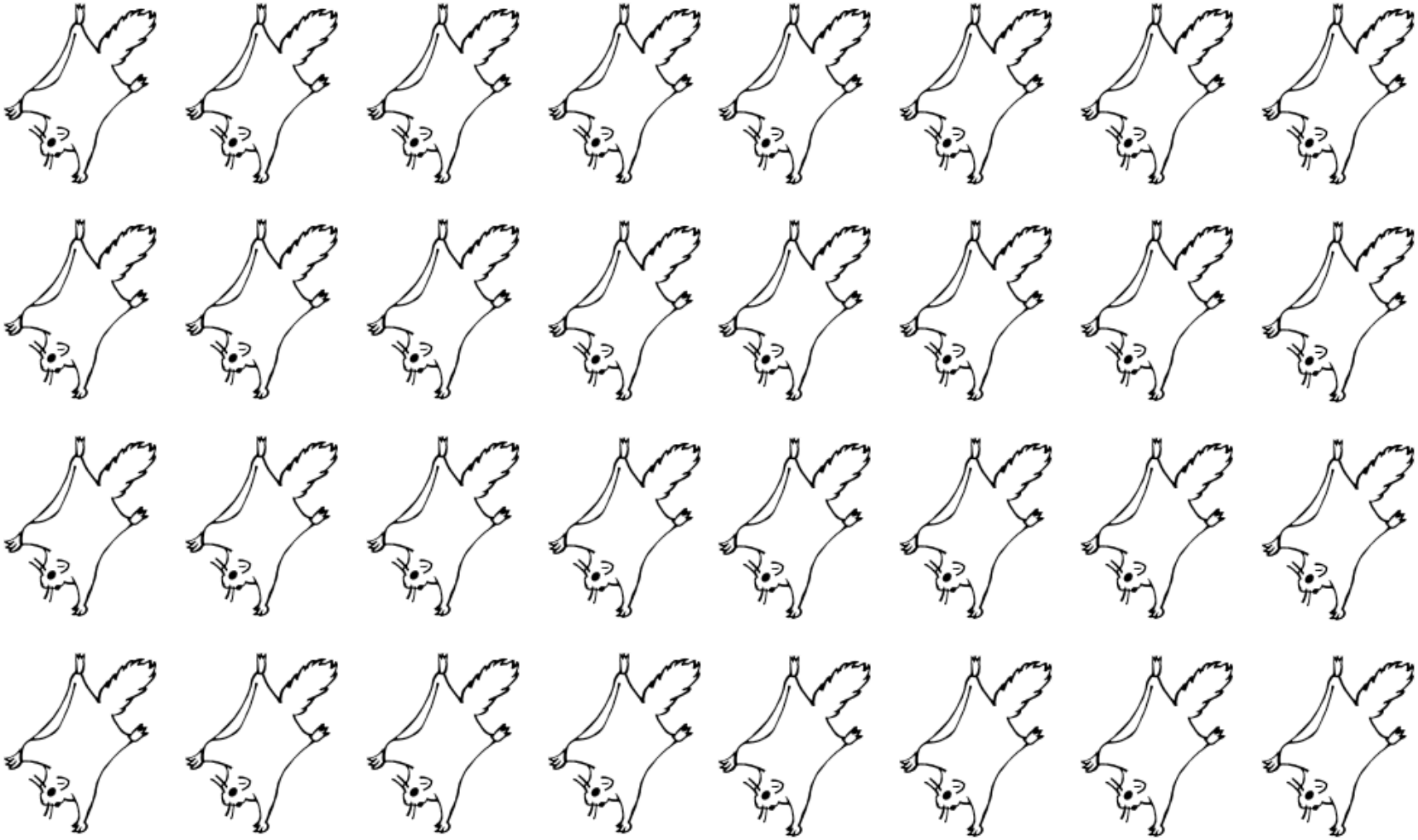
Silver, Z. 2016. Capture-Recapture. Classroom Resources: Illuminations, National Council of Teachers of Mathematics.

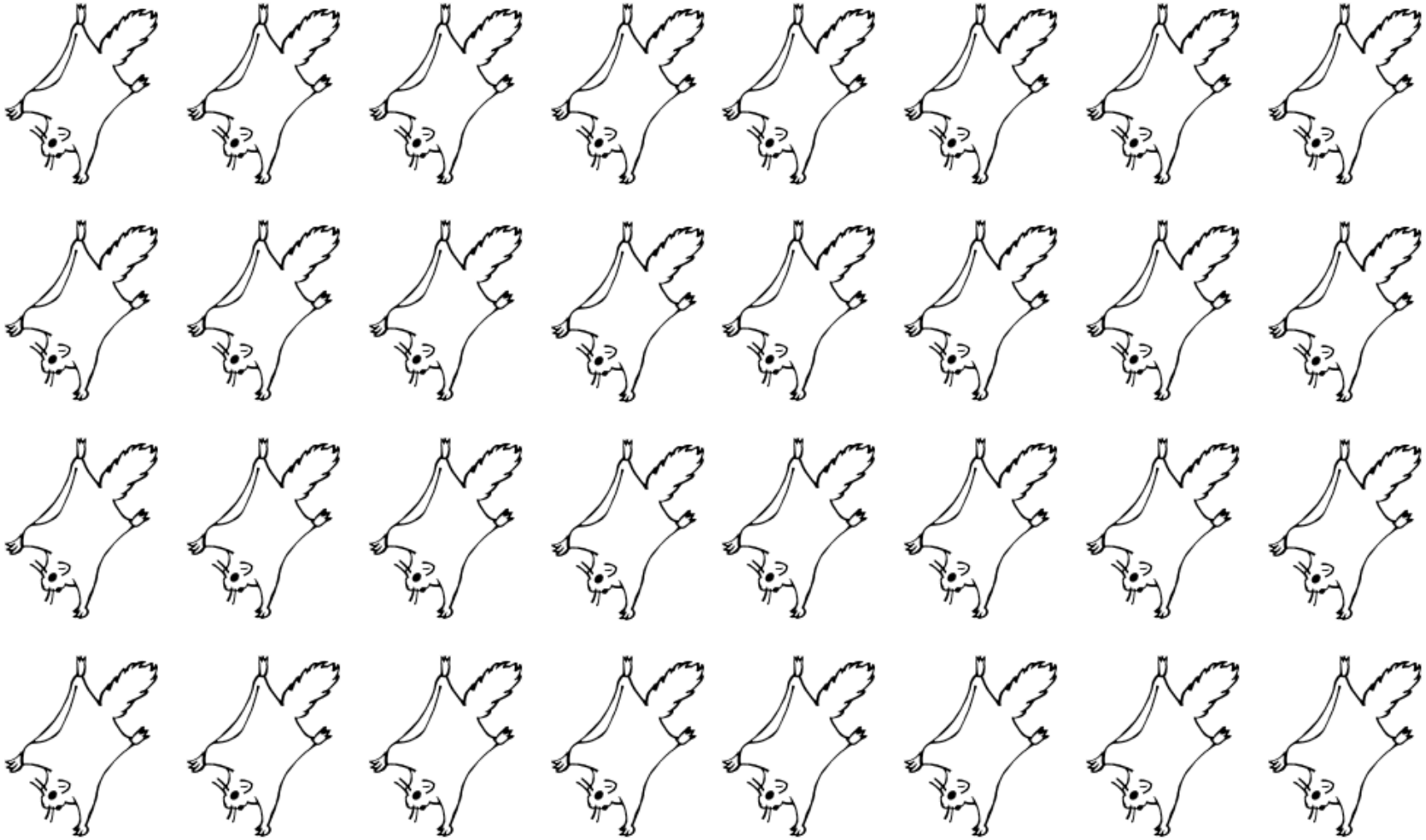
Adapted by Virginia Parkman, Kelly Sturner, and Suzanne Lenhart

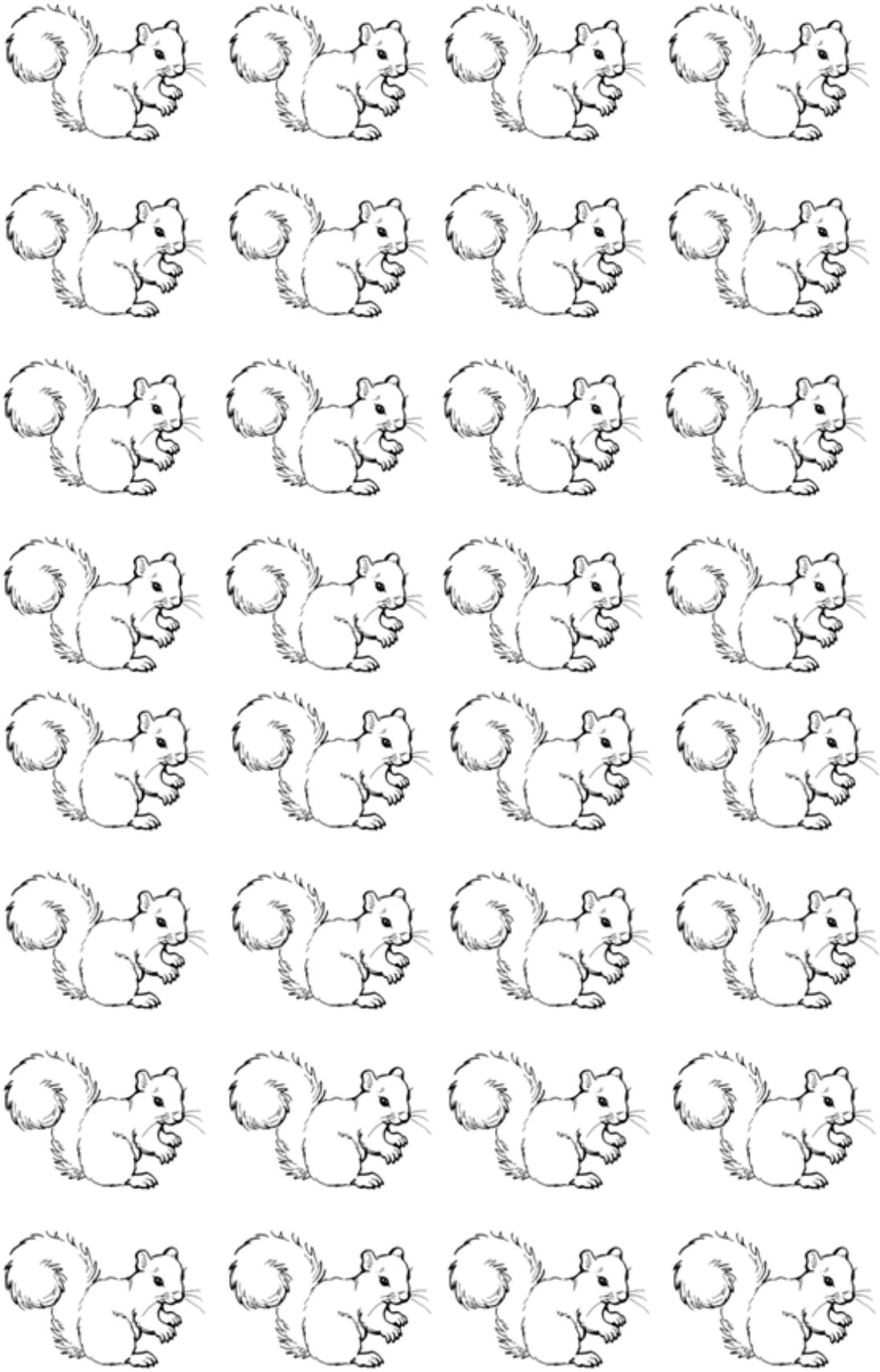
Thanks to Elizabeth Hobson for help in shaping this activity.
Flying Squirrel Picture: http://www.clipartbest.com/clipart-McLL65b7i
Squirrel Picture: http://clipartion.com/free-clipart-9437/

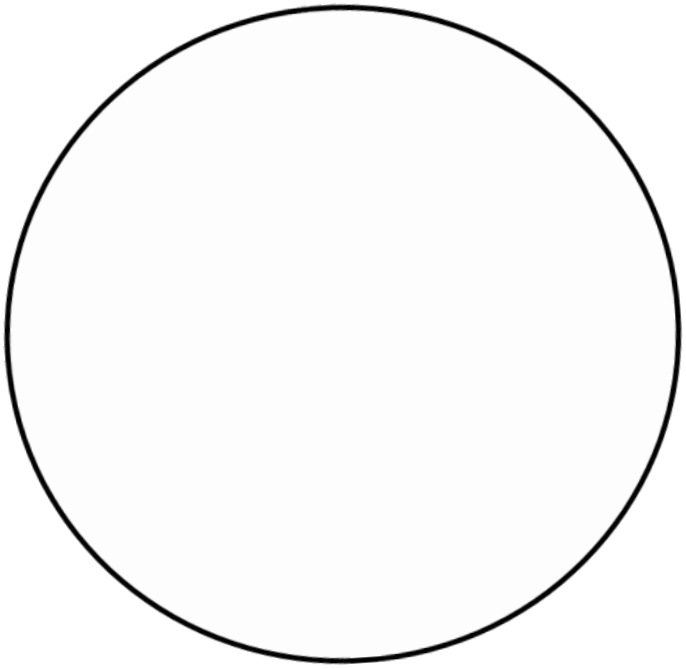
Alternative Materials:

- "Underbed" plastic boxes, 1 per group (~$9 each-reuseable) - replaces box top and simulates the habitat area
- Paper taped to the bottom of boxes marking out 10-16 equal rectangular sections (regions) - each must be a little larger than the area of the trap.
- Great Northern Beans, 2 lbs (or ~ ⅓ cup of beans per group) (~$3 total) - replaces cut out flying squirrels
- To mark beans -- use Sharpie markers rather than another kind that might rub off, 1 per group
- Pine bedding, ½ cup per group (~$3 total) - replaces the blank cut up printer paper and regular squirrels and simulates vegetation and other cover in the squirrel habitat
- Plastic cups, 18 oz, with the bottoms cut away such that the rims and about 1 ½ inches of the cup wall remain, 1 per group (~$3 total, reuseable) - replaces the cut out circle and simulates the squirrel trap.









Estimating population sizes: How many flying squirrels are in your area?

Imagine you are an ecologist who studies flying squirrels, an endangered species in Tennessee. You need to know how many flying squirrels are left in their habitat. How will you count them without having to trap or capture every single one? What is the best way to estimate their population size? Let's do a simulation to find out!

Method 1: Count the flying squirrels (beans) that you trap in sample regions, then estimate the total number of flying squirrels in the entire habitat.

Directions: Your teacher will randomly choose 4 regions in the habitat where you will capture flying squirrels (beans). In the table provided, record the four sample regions announced by your teacher. Then, use your trap to capture once in each region, finding the number of flying squirrels in your captured sample. Do not reintroduce the flying squirrels to the habitat until you have used your trap once in each region and counted all of the captured flying squirrels.

Sample Region	**# of Flying Squirrels**
1st:	
2nd:	
3rd:	
4th:	
Total =	
Average =	

You are sampling from four regions. What is the total number of regions in your habitat? _____

Average # of flying squirrels per sample region	X	total # of regions	=	Estimated total # of flying squirrels
_____	X	_____	=	_____

Question 1: Do you think the actual population of flying squirrels is higher or lower than your estimate? Justify your answer.

Question 2: Do you think this is a good method for estimating the population of flying squirrels? Justify your answer.

Method 2: Mark/Recapture Experiment

Step 1: Your teacher will again randomly choose 4 regions in the habitat where you will capture flying squirrels. This time, when you trap from the four sample regions, fill in the table below. After counting all of the captured flying squirrels, record the total below. Then, mark each flying squirrel with a black marker. After successfully marking all of the flying squirrels, place them back into their habitat. Mix up the squirrels to simulate their dispersal throughout the habitat.

Sample Region	**# of Flying Squirrels**
1st:	
2nd:	
3rd:	
4th:	
Total Marked:	

1.) How many total flying squirrels did you trap in Step 1? _____

Step 2: Your teacher will randomly choose 4 new regions. Trap in these four regions. After trapping, do not place the flying squirrels back into the habitat. Instead, count and record the total number of flying squirrels that you trapped. Then, count and record how many of the flying squirrels were marked and unmarked.

2.) How many total flying squirrels did you capture in Step 2? _____

How many of the captured flying squirrels were recaptures? _____

How many of the captured flying squirrels didn't have marks? _____

Step 3:

Most field ecologists use the generic proportion below:

$$\frac{Marked\ in\ Sample}{Total\ in\ Sample} = \frac{Marked\ in\ Population}{Total\ in\ Population}$$

For this trapping experiment, the new proportion equation is below. We can use this equation to estimate total number of flying squirrels.

$$\frac{\#\ Recaptured\ Flying\ Squirrels\ Caught\ in\ 2nd\ Trap}{Total\ \#\ of\ Flying\ Squirrels\ Caught\ in\ 2nd\ Trap} = \frac{\#\ of\ Flying\ Squirrels\ Caught\ in\ 1st\ Trap}{Estimated\ Total\ \#\ of\ Flying\ Squirrels}$$

Solve for the estimated total number of flying squirrels. Show your work. Put your data in the new proportion equation above.

$$Estimated\ Total\ \#\ of\ Flying\ Squirrels = \underline{\hspace{6cm}}$$

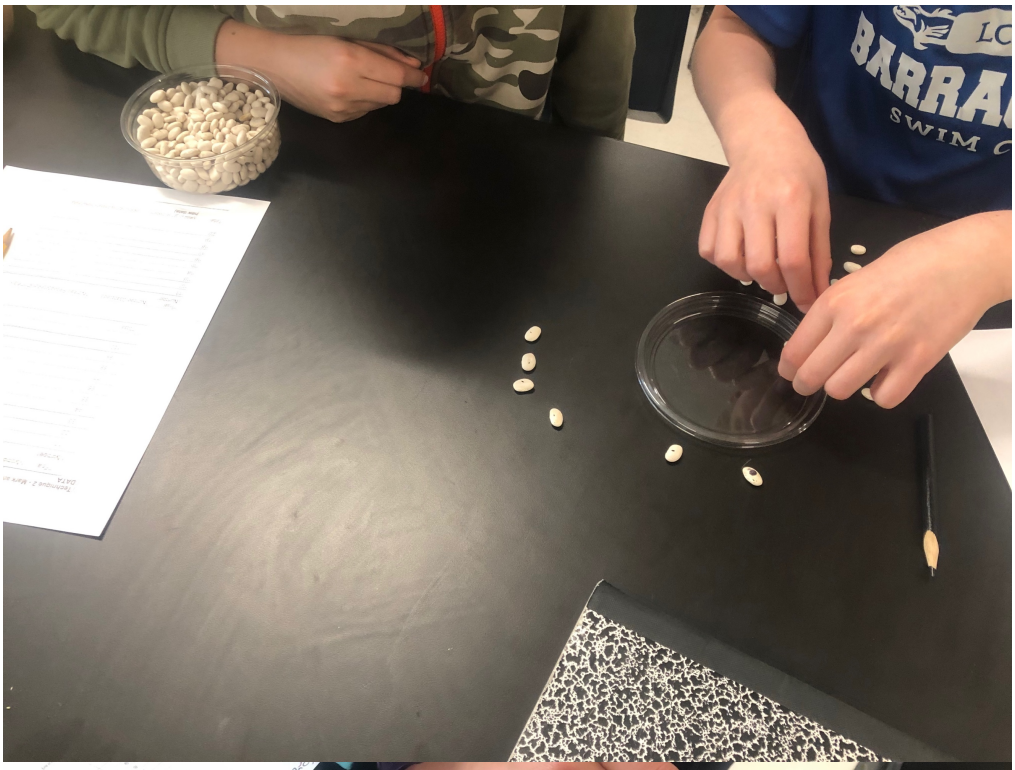
Question 3: How do Method 1 and Method 2 differ?

Question 4: Which method produced the larger population number of flying squirrels? Why do you think that occurred?

Question 5: Which method gives an estimate that you think is closest to the real number of flying squirrels? Justify your answer.

Question 6: Does using math to help estimate the squirrel population make your work as an ecologist easier? Justify your answer.

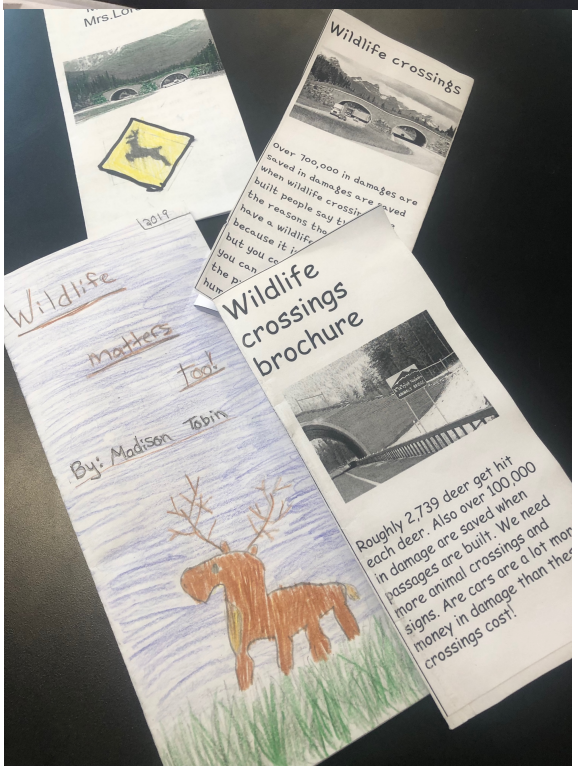
Appendix G




Technique 2 - Mark and Recapture
DATA
Trial Number
Number Captured
1
2
36

Appendix H


Wildlife Crossings
Protect animals!
Build crossings
by:Poppy
SLOW DOWN
WILDLIFE
CROSSING
SLOW DOWN
By:Alto Mcnally
Wildlife Crossings
Save Our Animals
BUILD CROSSINGS
Caution, Wildlife Crossing
bunny
Wildlife crossings
Over 700,000 in damages are saved are saved when wildlife crossings are built. People say that one of the reasons that we do not have a wildlife crossing is because it costs too much money but you can save money and you can save n animal lives in the process and maybe even humans as well.
Wildlife Crossing
Help these animals!
Wildlife crossing's
Wildlife crossings brochure
Hoatey
Roughly 2,739 deer get hit each deer. Also over 100,000 in damage are saved when passages are built. We need more animal crossings and signs. Are cars are a lot more money in damage than these crossings cost.
Road kill
by Isaac
Slow down
Wildlife is Important too
Animal Crossing


Wildlife crossings
Over 700,000 in damages are saved are saved when wildlife crossings are built. People say that one of the reasons that we do not have a wildlife crossing is because it costs too much money but you can save money and you can save n animal lives in the process and maybe even humans as well.
Wildlife matters too!
By: Madison Tobin
Wildlife crossings brochure
Roughly 2,739 deer get hit each deer. Also over 100,000 in damage are saved when passages are built. We need more animal crossings and signs. Are cars are a lot more money in damage than these crossings cost!

Appendix I: Wildlife Crossings Brochure/Flyer Rubric

Skills	4	3	2	1	SCORE
Use of Time	Student uses time in class and out of class to work productively and efficiently. Project is turned in on time.	Student uses most of their time to work productively and efficiently. Project turned in on time.	Student uses some of their time to work productively but project is not turned in on time.	Student does not use their time wisely. Project is late.	
Pictures/Graphics/Quotes	Pictures, quotes, and graphics are appropriate and used to enhance topic.	Pictures, quotes, and graphics are appropriate but not necessarily used to enhance topic.	Few pictures, quotes, and graphics used or ones used are not appropriate.	Pictures, quotes, or graphics not included.	
Use of Data	Actual data is used to enhance message of flyer. Data presentation is student generated.	Actual data is used in flyer and is student generated but may not be accurate or completely correct.	Data used in flyer is copied from another source and is not student generated.	No data is included in flyer.	
Visual Clarity & Appeal	Brochure/flyer has an excellent design and layout. It is neat and easy to understand the topic.	Project has a nice design and layout. It is easy to read.	Project needs improvement in design, neatness and/or layout.	Project is not easy to read due to needing significant improvements in design, neatness, and layout.	
Content, Spelling, Grammar, Punctuation	Project has excellent grammar, spelling, punctuation. Content is original and appealing to reader.	Project has 1 – 2 grammar, spelling, or punctuation errors. Content is original and mostly appealing to reader.	Project has 3 – 5 spelling, grammar, or punctuation errors. Content is original.	Project has multiple spelling, grammar, or punctuation errors. Content is not original and may be copied and/or pasted from another source.	