# Estimating the Area of a Reservation

## Fast Facts

Curriculum Area: Mathematics
Grade Level: Grade 6
Suggested Duration: 90 minutes

## Stage 1 Desired Results

### Established Goals

**Montana Content Standards for Mathematics**

**Measurement and Data (3.MD.6.)** Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units).

**Number and Operations – Fractions (5.NF.4)** Find the area of a rectangle with fractional side lengths by tiling it with unit squares of the appropriate unit fraction side lengths, and show that the area is the same as would be found by multiplying the side lengths. Multiply fractional side lengths to find areas of rectangles, and represent fraction products as rectangular areas.

**Statistics and Probability (6.SP.3)** Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number.

**Rations and Proportional Relationship (6.RP.3)** Use ratio and rate reasoning to solve real-world and mathematical problems from a variety of cultural contexts, including those of Montana American Indians, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

**Indian Education for All Essential Understandings Regarding Montana Indians**

**Essential Understanding 4** Though there have been tribal peoples living successfully on the North American lands for millennia, reservations are lands that have been reserved by or for tribes for their exclusive use as permanent homelands. Some were created through treaties, while others were created by statutes and executive orders. The principle that land should be acquired from tribes only through their consent with treaties involved three assumptions:
*I. Both parties to treaties were sovereign powers.*
*II. Indian tribes had some form of transferable title to the land.*
*III. Acquisition of Indian lands was solely a government matter not to be left to individual colonists or states.*

### Understandings

- the concept of area

- how to find area of figures on a grid
- reservation borders are not necessarily straight
- how to use a grid to estimate area of an irregular shape
- estimates can vary
- the mean of a data set can be used to represent class data.

### Essential Questions

- Why are the figures formed by reservation boundaries often irregular shapes?
- How can the area of an irregular shape be estimated?
- How does finding the area of an irregular shape differ from finding the area of shapes such as triangles or rectangles?

### Students will be able to…

- describe the area of shapes in square units. (3.MD.6)
- find the area of shapes on a grid to the nearest half square unit. (5.NF.4)
- use a grid to estimate the area of irregular shapes. (5.NF.4)
- choose the best measure of central tendency to represent a set of data. (6.SP.3)
- find the approximate area in square miles of the Flathead Reservation. (6.RP.3)

### Students will know…

- the definition of area.
- that area is described in square units.
- that different shaped figures can have the same area.
- strategies for estimating area.

## Stage 2 Assessment Evidence

### Performance Tasks

1. Area Worksheet
2. Estimated Area of Reservation: Result and Description of Method
3. Final Individual Performance Task
4. Design Your Own Boundaries Worksheet (with figure drawn on grid paper and turned in).

### Other Evidence

1. Participation in class discussions.
2. Individual questioning of students.
3. Observation of student methods for grid placement and counting strategies.

# Stage 3 Learning Plan

## Learning Activities

**Review concept of area**
Ask students to define area.

If students describe the concept of area using real world references such as the area around their desk, an area rug, or the quiet area of a library, question student responses to clarify their understanding. Ask what type of space to students who say the "space" inside a shape. "Can it be the space inside a box?" "Is the area around your desk only on the floor or all around you from floor to the top of your head?"

Questioning their ideas and asking them to justify and clarify will help lead students to think about the concept of area and develop the understanding that area is the "space" inside a two-dimensional figure, not a three-dimensional figure.

If students give a formula such as length times width, explain that the formula is one method for finding area of a rectangle, but ask, "Why?" "Where does it come from?" (Formulas come from recognized patterns. In a rectangle, multiplying the length and width is a fast way of counting the number of square units covering the inside of the rectangle.) You can use an interactive tool to show how the formula represents the number of square units in the grid covering a rectangle. (3.MD.7)

Some students may confuse perimeter with area. Make the distinction between linear measurement (length of a line segment as one single dimension) and area (which is two dimensions). Draw a figure on the board and have students identify where the area is in contrast to the perimeter. Using a pipe cleaner bent into any shape polygon, you can show that area only exists when there is a two-dimensional figure. Unbend the pipe cleaner into a single line segment to show that perimeter is a single length; ask students where the area is now? (Area only existed when there was a two-dimensional figure.) The measurement of the perimeter still exists as a single length represented by the line segment of the "unbent" pipe cleaner, but the area cannot be represented by a single length.

Note that area of two-dimensional figures is measured in square units due to the ease of counting squares and their ability to tessellate (fit together in a plane with no gaps or overlaps). This provides a consistent measuring tool for describing area. The units can be square centimeters, square inches, square yards, square kilometers, etc.

Explain that students will be looking at several different shaped figures and trying to determine the area of each figure.

**Hand out Area Worksheet**
Read Question 1 aloud and ask students to answer it. Have students share their predictions and reasoning with whole class or in small groups.

Read the remainder of the worksheet aloud and ask students to complete Question 2. Have students share a variety of methods and strategies for determining the area of each figure. (Examples: Forming

one square unit using two half squares, extending figures F and G to form rectangles, counting the squares in the rectangle, and then dividing the result by 2.

**Display map of Montana Indian Reservations**
Read aloud and discuss the information about Indian reservations on "Background Information on Indian Reservations" document (see attached).

Look at the map and ask students, "What do you notice about the shapes formed by the boundaries of the reservations?" (irregular shapes, curved edges) "Why do you think the shapes are irregular?" (Some border mountains, land that was sold or taken may follow geographic details such as rivers, roads, etc. which are not always straight.) "How might this make it difficult to find the exact area of each shape represented by the reservation boundaries?" (Cannot match a square grid exactly to count squares.)

**Handout map of Flathead Reservation and overhead transparency with grid.**
Assign student partners.

Explain that each pair's task is to determine, as closely as possible, the number of square units in the area of the figure formed by the boundary lines of the Flathead Reservation. One square unit is defined as one square on the transparency grid. They may use a variety of strategies and materials to complete this task. Students should be prepared to present their findings and share their method with the class.

Make available vis-à-vis pens, tape (for holding grid in place over map), scissors, glue sticks.

**Compile the class data.**
Have partner pairs share their results and the method they used to obtain it.

Record each pair's results on the board.

Ask why the values vary. (All are estimates.)

Based on the data, discuss which estimate students think best represents the figure's area and why.

Ask students to come up with one value they will use to be the "average" area of the figure. Students may choose to find the arithmetic average (mean) by adding all the values and dividing by the number of estimates listed. Once complete have students compare this to the list on the board to be sure they agree it is a good average estimate. If the data has one particularly low or high estimate, it can affect the mean. A low value will bring the mean value down and a high value will raise the mean value. If there are any of these "suspicious" values, such as one that is far off from others, the class might want to use another method, which might include choosing the most frequently occurring value (mode) or considering an extreme low or high estimate as an error in the counting of squares and recalculate the average (mean) without this value.

**Calculate the approximate area of Flathead Reservation in square miles.**
Explain that each square unit on the map represents approximately 47 square miles in actual area. (Adjust value if map is printed at different scale than current printed document of approximately 1 cm = 6.86 miles.)

Ask students to brainstorm with their partners how they could use this information with the chosen class average to estimate the number of square miles within the Flathead Reservation boundary (42 times the number of squares).

Complete the calculation and compare to land base estimates of nearly 1,938 square miles.

**Handout individual performance task, Design Your Own Boundaries.**
Read assignment directions with students.

Have students complete the task in class or as an at-home assignment. The assessment allows for struggling students to complete a near rectangle shape with alteration of only one side of the figure. Encourage more advanced students to consider more realistic shaped boundaries like those appearing on the Montana Reservations map. You may also suggest they try different approaches to confirming the total area for their justification in Question 2.

**Turn in completed designs.**
Post designs for students to see the variety of irregular figures that can have the same estimated area.

**Contrast finding the area of irregular figures to known shapes such as rectangles and triangles.**
Ask how finding the area of irregular figures like those represented by Reservation lands compares to finding the area of rectangles and triangles. Allow students to share ideas and observations. Students should notice that for many of the rectangles and triangles they were easily able to cover the area with full or half squares due to the straight edges on the boundary of the figures. In the case of some triangles, they can be rearranged or be duplicated and arranged to form another shape such as a rectangle or parallelogram, which makes it easier to count the squares inside. For the figures with irregular borders, some of the area can be broken into familiar shapes that are easier to count (like rectangular regions), but then the pieces with curved edges are harder to judge if they are half or a fourth of a square unit. With curved pieces you cannot as easily tell if they fit together to make a whole square unit. With straight lines it was often more obvious if the pieces fit and you could many times get an exact area versus an estimate.

## Materials/Resources Needed

- Copy of "Area Worksheet" for each student (attached)
- Copy of Montana Indian Reservations map from *Montana Indian Their History and Location*, 2016, page 3. *Tribal Lands in Montana map* (attached)
- Background information on history of reservations (attached)
- Copy of the Flathead Reservation map for each pair of students. (attached) *[For larger map Flathead Reservation map scale on this figure 1cm=2.43 miles]*
- Copy of "Design Your Own Boundaries Worksheet" for each student. (attached)

- 1-cm squares (10 mm squares) grid printed on overhead transparencies, one for each pair of students (free online grid paper)
- vis-à-vis pens or wipe-able markers
- tape
- scissors
- glue sticks
- one pipe cleaner or segment of bendable wire

## Additional Resources

Interactive Tool to show how the formula represents the number of square units in the grid covering a rectangle

## Montana Content Standards and IEFA Essential Understandings Regarding Montana Indians

Montana Content Standards for Mathematics – Grade 3

Montana Content Standards for Mathematics – Grade 5

Montana Content Standards for Mathematics – Grade 6

Essential Understandings Regarding Montana Indians

# Area Worksheet

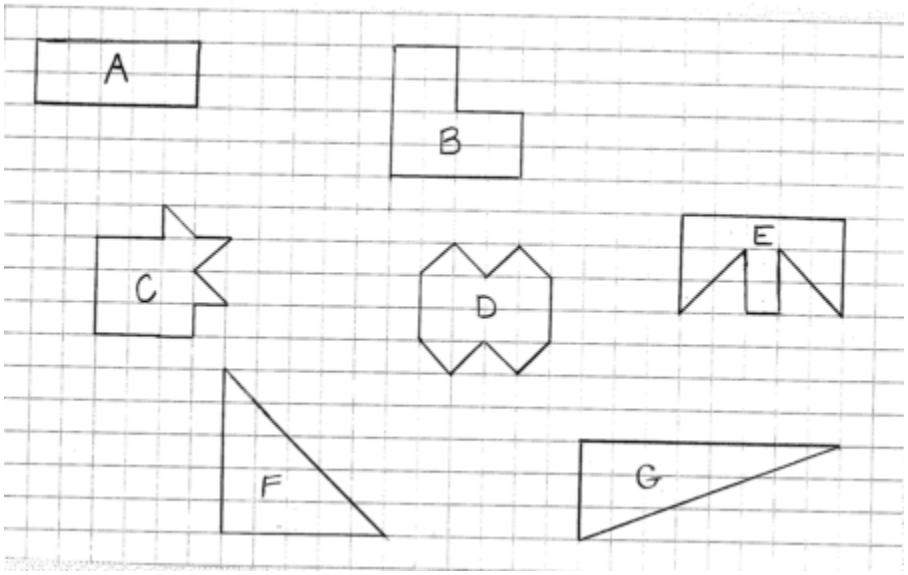
Name _____

1. Look at the figures A-G shown below.

    a. Which figure appears to have the greatest area? _____

    b. Which figure appears to have the least area? _____

    c. Which figures might be equal in area? _____




**If ___ is 1 unit long, then ☐ is one square unit in area.**

**The area of a figure is measured in square units.**

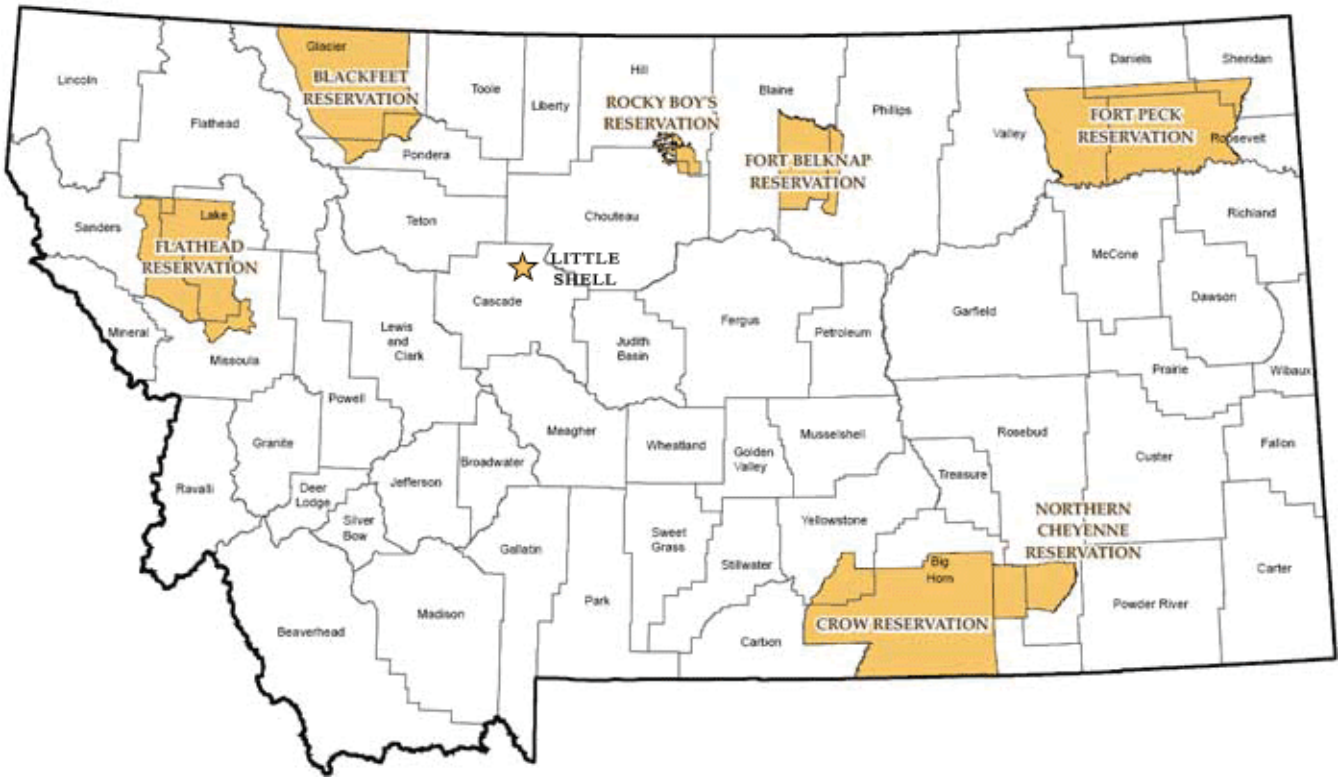
2. For each figure shown above, determine whether the area of each figure is less than, equal to, or greater than 12 square units.

    Figure A _____ Figure B _____ Figure C _____

    Figure D _____ Figure E _____ Figure F _____

    Figure G _____

# Tribal Lands in Montana Map




Map provided courtesy of Governor's American Indian Nations (GAIN) Council)

# Background Information on Indian Reservations

(Excerpts from OPI's Indian Education for All document, *Montana Indians Their History and Location,* 2009, pages two and three. This document has been updated. The one on the OPI Web site does not contain this introduction).

**The First Best Place**

Long before Montana became known as the "last best place," Indian nations and Indian people knew this area as "the first best place." Before there was a state called Montana, several tribal nations called this area "home." In addition to the tribal nations that are currently located in the state, the Mandan, Hidatsa, Arikara, Nez Perce, and Shoshone, among many others, also have historical roots in this territory.

Indian people lived here, raised their families here, taught their children here, and knew this land and its seasons intimately. They knew their homeland was extraordinary and that the terrain could be both generous and unforgiving. This is a sacred place. Their stories are tied to this land. Their histories, religions, and philosophies are connected to this location. Their contemporary lives are still united with the landscape of this locale. This place remains, to the tribes and tribal citizens who live within the boundaries of what is now known as Montana, the first best place to live and carry on their way of life and traditions.

**Indian Reservations**

The introduction to the saga of this state, and indeed the nation, is focused on the land. Conflicts, battles, and struggles over land possession ensued when very different and inconsistent value systems and cultures collided. The issue of who would control and define the terms of "ownership" guided much of the relationship, and clashes, between tribal nations, the federal government, state government and individual Euro-Americans.

During the late 1800s, the fledgling U.S. Government and the established tribal nations located in this area entered into treaties that created, among other things, boundaries for each of their respective citizens. The premise that land could be acquired from the Indian nations only with their consent through the negotiated terms of treaties involved three assumptions: 1) that both parties to the treaty were sovereign powers; 2) that the Indian tribes had some form of transferable title to the land; and 3) that the acquisition of Indian lands was solely a government matter not to be left to individual colonists/settlers.

It is under these three assumptions that treaties were constructed. As such, treaties created a system whereby, in theory, tribes reserved portions of their homeland for themselves. Hence, the term "reservations." It was not land that was "given" to them. In fact, tribes ceded particular tracts of their homeland to the U.S. Government for settlement by U.S. citizens, which were called "homesteads," as well as for railroads and for gold exploration and other resources needed by this new government. The reality, of course, is that there were very few negotiated treaty terms. The U.S. Government

“negotiated” with the tribes under coerced conditions in order to establish a larger land base for itself, states, and its citizens.

And now, the rest of the story. It was said by Mahpiya-Luta, or Red Cloud, an Oglala and Brule’ (Lakota Sioux): “They made us many promises, more than I can remember, but they only kept one; they promised to take our land, and they took it.” The U.S. Government did not keep its promises. The terms of the treaties were broken - in every instance. The negotiated reservations of land continued to shrink as more and more immigrants discovered this first best place. Indian people were left with very few choices; they learned to live with new neighbors, their different way of life, and their contrasting worldviews.

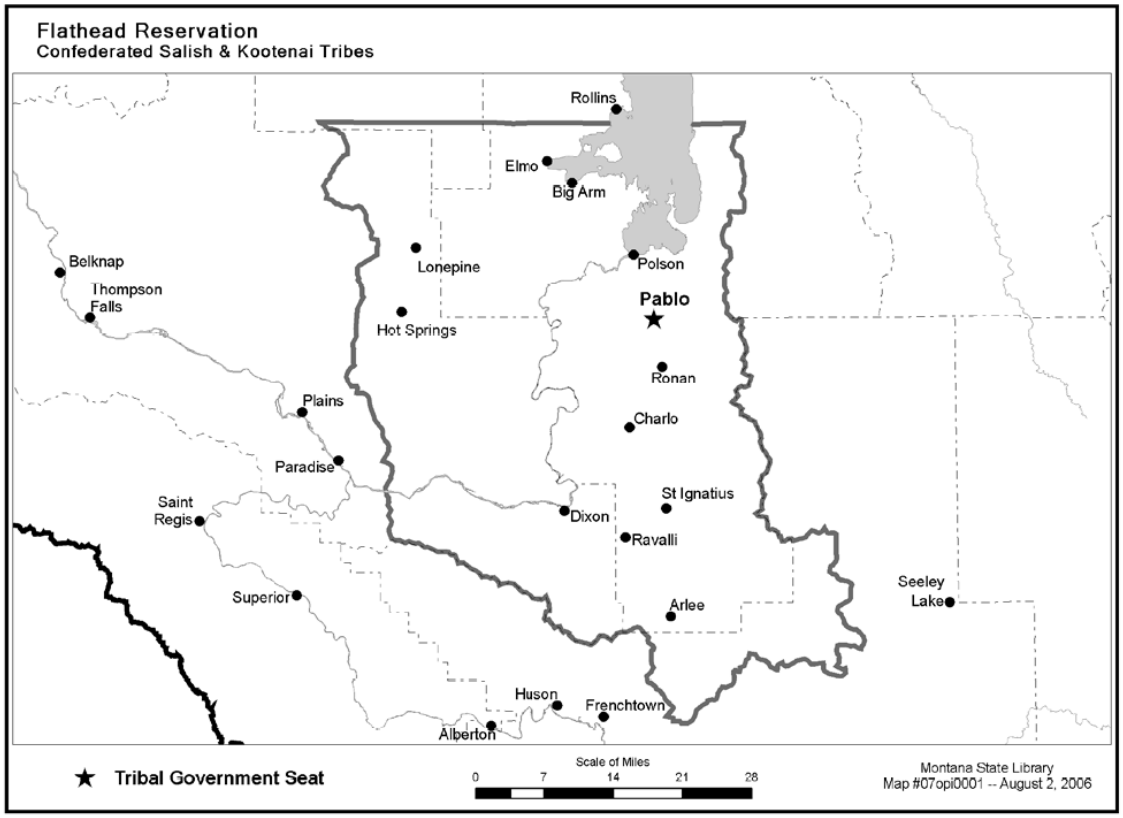
The story of Montana, at its beginning, is one simply about survival for tribal people. Each tribe has its own stories about the U.S. Government’s failed attempts to “fix the Indian problem” through policies that were meant to assimilate their people into an American way of life, and, in some cases, terminate tribal governments and cultures entirely. Tribes have their own stories about surviving the slaughter of the bison - their primary food source. And today, they still acknowledge the destruction brought on by disease epidemics. Still, they remain. Still, they govern themselves through their sovereign status as nations within a nation. Still, they tell their own stories that tie them to this first best place. The brief histories in this publication, written by tribal people, tell a part of their stories.

**The Contemporary Landscape**

Twelve tribal nations eventually came to rest within the boundaries of Montana. Eleven of these nations reside within their reserved homelands - reserved either through treaties or executive order. One, the Little Shell Band of Chippewa, is “landless,” but it currently seeks federal recognition and to establish its own land base. These tribal nations govern seven reservations that comprise nine percent of Montana’s land base. There are also many Indian people, from all of the tribes, who live off reservations, in towns and cities across Montana.

Indian people, whether they live on or off reservations, contribute economically, culturally, socially, and politically to Montana’s landscape and history. Each tribe has its respective government that establishes services for its citizens. Each tribal government, as does any government, continues to assert its sovereignty to create a better future for its members. Tribes and tribal citizens continue to play a vital role in the chronicles of Montana."

# Flathead Reservation Map




(1 cm = 6.86 miles. Square cm = 47 square miles)

# Design Your Own Boundaries Worksheet

Name _____

Use 1 cm grid paper to complete the question below. One small square represents 1 square mile.

1. Draw an irregular figure that…
    a. could represent a reservation of land with an approximate area of 39 square miles.
    b. is a figure that shows the boundaries of a particular region. It does not have any open sides.
    c. has one or more sides that are not straight-line segments.

2. Justify how you know your area is approximately 39 square miles.

# Area Worksheet Answer key

1. a.-c. Student response will vary
   Revisiting after Question 2 will reveal: **a.** F b. A **c.** B, D, & G

2. Figure A: less (10), Figure B: equal; Figure C: less 910.5); Figure D: equal; Figure E: less (11), Figure F: more (12.5, Figure G: equal

# Design Your Own Boundaries Answer Key

1. Check students' sketches.

2. Answers will vary. Justifications may include counting of whole and partial squares to form wholes, rearranging of squares to form full squares or a more familiar geometric shape, or possibly enclosure of shape in a larger familiar geometric shape of close to but greater area than original.