Visionmaker NYC Education
Wildlife Conservation Society 2016

MODULE 2, Lesson 1: 8.5 Million and Counting: Introduction to Population EPI

Grades: 6-12

Duration: 4-8 class periods (each 45-50 minutes)

Objectives: By the end of this lesson, students will be able to:

- Understand human population and density, and the environmental impacts as these increase and decrease
- Discuss urbanization and the benefits and tradeoffs associated with its increase globally
- Create potential solutions for balancing the benefits of urbanization with the benefits of wild places
- Build science literacy skills such as reading graphs and analyzing data, making arguments and justifying with evidence

Materials: Activity 1 – measuring tape, string/yarn/masking tape/chalk (to mark off square on the ground), computer(s) with internet, world map and US map digitally or hard copy, Population Comparison Worksheets, graph paper, skittles or similar small item, pencils/pens; Activity 2 – Location and Data Card Sets, Teacher Answer Key, Evidence Worksheets, pens/pencils; Activity 3 – Computer with internet and projection abilities or printed copies of images to show students, computers with internet for multiple groups of students, Vision Comparison Worksheets, pens/pencils

Suggested Standards:

NYS Content Standards:

Grades 6-8 General Science Standards
Standard 1—Analysis, Inquiry, and Design
M2.1
S1.3
S1.4
S3.2
T1.3
Standard 2—Information Systems
1.2
3.1
3.2
Standard 6—Interconnectedness: Common Themes
2.2
6.1
Standard 7—Interdisciplinary Problem Solving
1.3

Grades 6-8 Life Science Standards
Standard 4:
7.1a
7.1b
7.2c

Grade 8: Social Studies Practices
C.1.
8.2a
8.2b

Grades 6-8 Technology Standards
Standard 5 – Technology
3.
4.

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Grades 9-12 General Science Standards:
Standard 1:
1.1a
1.2a
1.2b
3.1a
M1.1
M2.1
Information Systems Key Idea 1
Standard 6—Interconnectedness: Common Themes
Systems Thinking Key Idea 1
2.2
Standard 7—Interdisciplinary Problem Solving
1.1
1.3
Strategies Key Idea 2

Grades 9-12 Earth Science Standards
Standard 4
2.2c

Grades 9-12 Living Environment Standards
Standard 4:
6.1f
7.1c
7.2a
7.2c
7.3a

Social Studies Practices Grades 9-12
4
5
6
D.2.
D.3.
10.8a
10.9c

Grades 9-12 Technology Standards
Standard 5 – Technology
3.
4.

Common Core State Standards:

College and Career Readiness Anchor Standards for Writing
2.
4.
College and Career Readiness Anchor Standards for Speaking and Listening
1.
3.
College and Career Readiness Anchor Standards for Language
1.
2.
6.

Reading standards for literacy in Science and Technical Subjects
3.
4.
7.
Writing standards for literacy in History/Social Studies, Science and Technical Subjects
2.
4.
Mathematics Standards
6.SP3
6.SP5
7.SP4
G-MG2

ACTIVITY 1:
Population Density (45-50 minutes)

The activities in this lesson serve to lay a foundation for students' understanding of the human population EPI as part of Visionmaker NYC. Begin by informing students that you will be talking about population. Depending on students' prior knowledge, engage them in a discussion to establish some baseline information:

Mark off an approximately 5 foot by 5 foot square on the floor (you can do this inside or outside). Invite 1 student to enter the square, then another, then another. Continue until they physically cannot fit any more bodies into the square.

How did this make students feel? When were they comfortable vs. not comfortable? How might this activity relate to our conversation about population today? Elicit ideas such as that the number of people in the box were the population of that box. Population can vary, and depending on the population, an area can be more or less crowded, some students may be familiar with the concept of overpopulation. Density may come up here as well.

What do we mean when we use the word population? How about specifically for humans?

Depending on the prior knowledge of the students, have either a brief conversation or use these questions to develop into a short activity:

- Does anyone know what the global human population is?
    - If not, can someone look it up?
    - Is that population evenly distributed?
    - Does every country have the same population?
    - How about every state within a country?
    - Explain; what does this mean?
- If students are not already familiar with this information, split the class up into small groups and instruct them to look up the global population, then to find the populations of the countries listed on the Population Comparison Worksheet at the end of this lesson. The countries they look up are not important; if there are other locations that are more relevant to the students, you can have them find the populations of those places. The countries listed on the worksheet were chosen because they represent one nation from each continent, and are more likely to be places familiar to the students.
- Pull up a map to point out these locations while students are discussing the populations to make sure students understand where each country is located.
- Have students come back together and share out what they found. Now students should be able to answer the questions above: What is the global population? Is that population

evenly distributed? Does every country have the same population? How about every state within a country? Explain; what does this mean?

Where are some places that have high human populations? Low populations? In these places are humans distributed evenly? Bring out the ideas of population density and distribution – e.g. urban areas tend to have very concentrated/clustered/aggregated populations, while suburban areas tend to have less dense, more uniformly spread populations, and rural areas tend to have the lowest density and the sparsest distribution of humans. Remind students about standing in the box at the beginning – did they experience high or low density? Fewer people in the box is lower density, more people is higher density.

Continue the conversation on population density with an example. Compare the US and Indonesia (be sure to show Indonesia on a map for geographical reference). The US has a total human population of approximately 321 million people and Indonesia has about 256 million people. The US is approximately 3.8 million square miles, while Indonesia is 741,100 square miles (another reference to a map is helpful to show size distinction). Show the students the calculation for population density.

US density = 321,000,000/3,800,000 = 84.47 people/square mile

Indonesia density = 256,000,000/741,000 = 345.48 people/square mile

So while the absolute populations are relatively similar, and the US has more people over all, the densities vary greatly, and Indonesia has far more people per square mile.

Here are two websites with graphics on population density that might aid your conversation:

- http://neo.sci.gsfc.nasa.gov/view.php?datasetId=SEDAC_POP
- http://data.worldbank.org/indicator/EN.POP.DNST

To help clarify this concept, have students further explore density using candy, such as skittles (you can also use any small item like beads instead of candy), and graph paper. Have students mark off 3 10x10 blocks of squares on their paper, separated by a few squares so the blocks do not touch. Instruct students to place 2 skittles in the first block, 5 in the second and 10 in the third. Ask students for their observations and interpretations of this. Students may make observations such as with only 2 skittles the skittles have more room or there is more empty space, while with 10 skittles the skittles are more crowded or you can't see as much of the paper. The goal is to get students to see and understand that each block of squares has the same area, thus as the number of skittles increases, the **population** of skittles, the **density** of skittles also increases. Just like when they were adding people to the box earlier.

Next have students mark off 3 more blocks of squares, the first 10x10, the next 10x20, and the last 20x20. Now instruct students to place 10 skittles in each block. Elicit observations and interpretations. Have students compare the various situations in terms of skittle density. The goal here is to facilitate student understanding that density can change as the population (number of skittles) changes within a fixed area or, as in this case, that density can increase or decrease when the same population is given more or less area to occupy.

Ask students to think of other examples of density and density disparities. If students are familiar with the concept of density of objects, a comparison can be drawn to this as well – discussing that it is the same idea just in terms of mass in a particular volume rather than skittles or humans in a given area. If students struggle with examples, some potential prompts could include: think about a classroom, how would your experience change if there were just 10 students in the class versus if there were 40 students in the class? Or they could think about traffic on the highway and density of vehicles. Perhaps comparing to the number of shoes they have in their closet, or how many books they need to fit into their backpack. Facilitate a conversation that will allow students to understand the concepts of density in a variety of contexts. Be sure to tie back to the idea of US versus Indonesia population densities to make sure this connection is clear.

ACTIVITY 2:
Comparing Cities (45-50 minutes)
So why do we care about human density? What impacts might it have for a given place?

Explore these ideas with a game comparing cities across the US.

Break students into small groups. This activity may be challenging for some students, so it is recommended to form groups that include a mix of stronger and weaker students. Additionally, an optional scaffolding strategy is described below as well.

Give each group a set of Location Cards and a set of Data Cards. These are included at the end of this lesson. They can be printed such that the Location Cards print single sided on their own and the Data cards are printed double sided with numerical data on one side and the corresponding graphs on the other side. Make sure that once printed the cards match up, with location a on both sides e.g. Students should work together to match the six data cards to the corresponding location cards. A teacher answer key is provided. Students should think about the population and density provided on the location card as they analyze the corresponding data - what correlations can they draw? For example, what impact might density have on transportation usage and solid waste production? How might the area of the city impact vehicle miles travelled? Students can also look at climate data for clues to help them match locations.

Optional scaffold: walk students through using the Identify and Interpret Strategy (I^2), which comes from the Biological Sciences Curriculum Study (BSCS), to help them interpret the data on the cards. Students look at the graphs or the data that they have presented to them and start by making observations of what they notice – what trends do they see? Then they can go a step further and interpret what those observations mean. This may help students find a place to start when faced by so many data points, and may help them to make sense of the information they are given to be able to draw conclusions from the data. You can read a full description of this strategy in this online PDF (http://bscs.org/sites/default/files/_legacy/BSCS_PDI_Notebooking_Student_Version_NSTA_2012.pdf). This strategy is also used in Module 5, Lesson 1.

As students decide as a group on their matches, at least one student should record their reasoning on the Evidence Worksheet. These bullet points will be useful for students to refer to when they discuss the decisions they made as a whole class.

Circulate while teams are working to answer questions, etc.

Once teams are finished, review as a group – what conclusions did they come to? Can they justify their thinking? What evidence did they record on their worksheet for their decisions? Even if a team has come up with solutions that are not accurate, encourage them to explain their reasoning and practice their science skills of justifying reasoning and crafting explanations. Do not reveal the correct answers; let teams discuss their responses and see what the class as a whole agrees on. Then you can review what the actual data reveals, discussing why each location has the status that it does based on its population and density.

Make sure this discussion enables students to draw connections between population, density, and resource use. For example, as density increases solid waste generation (trash) tends to decrease because people have smaller spaces and therefore buy and thus dispose of less waste. As density increases, people tend to drive cars less because locations are closer together and denser US cities tend to have more established public transit networks.

ACTIVITY 3:

New York City Now and Then: Urbanization Pros and Cons (Two-six 45-50 class periods)

Now that students have explored some of the implications that human population and density can have, and seen some of the positive impacts of increasing density, introduce Visionmaker NYC and let them go a little deeper.

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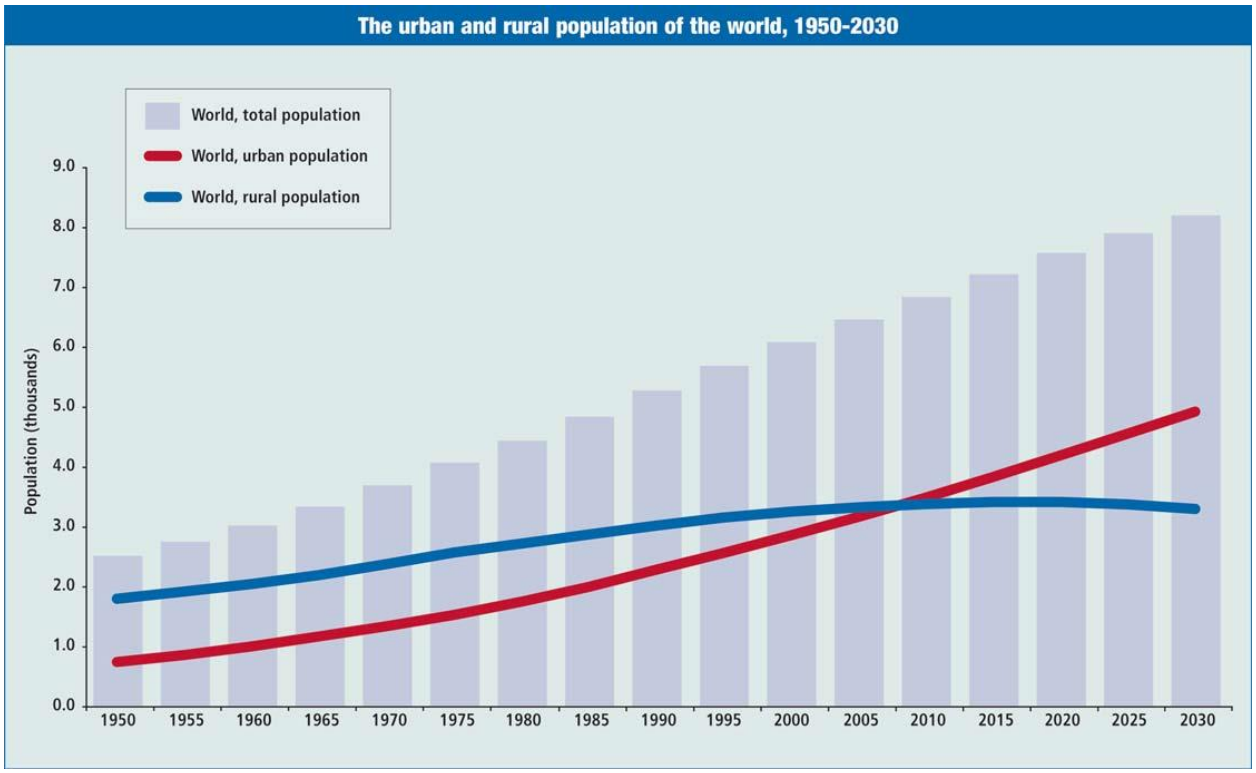
In this activity students will connect their learning about population density to the idea of urbanization as the means to increased density. They will observe the incredible spread of urbanization globally, and will explore the pros and cons of urbanization, and ways that the benefits of increased density as seen in activity 2, can be balanced with the benefits of natural environments.

To start, visit https://landsat.usgs.gov/gallery_view.php?category=nocategory&thesort=pictureId and select "World Cities" from the menu at the top of the page. This will display a number of comparative satellite images of cities over time that demonstrate the increased urbanization and growth of a number of cities all over the world. You can choose whichever images resonate with you to display for students. Tell the students the years the two images were taken and have students make observations of what they notice between the two – similarities as well as differences. What is going on in these photos?

After a conversation about urbanization, show students this graph:



Ask students:

- What do you notice?
- What does this graph show?

    - Guide students to understanding that more than half of the earths' population now lives in cities. Cities are growing and people are moving to cities from more rural areas.
    - Optional: you can also connect students' thinking to the unequal population distribution discussed in activity 1, and ask if they think the percentage of people in cities is the same in every country?
        - While the earth's total population is more urban than not, overall, countries vary, e.g. the US has 82% of our population living in urban areas, while India only has 33% of the population living in cities. You can check this data for any country in the world, here: http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS
        - This is slightly more advanced thinking so use your judgment whether to take students on this slightly tangential line of thinking. It is however, an excellent extension of the conversation from activity 1.
- Why do they think this might be?
- Why would people want to live in cities?
    - Think, jobs, culture, access to resources like markets or schools, shorter commuting time, etc.
- How do cities increase density?
    - Think, taller buildings with more residents, smaller lots and smaller living spaces, etc.

These trends are taking place right here in NY as well. Now show the students the images of Manhattan from 1609 and 2014, included at the end of this document. The modern image is a photo of lower Manhattan, looking north, and the 1609 image is a recreation of the exact same view based on what that area would have looked like in 1609.

- What differences can they notice?
- How has Manhattan changed in the last 400 years?
- Why might these changes have occurred?
- What might be some of the consequences of these changes – good and bad?

Record, on a whiteboard or smartboard, some ideas that come up about the possible negative and positive consequences of urbanization. They can think back to ACTIVITY 2 for ideas as well. Now that students have thought a little bit about urbanization, have them log into Visionmaker. See instructions on creating usernames and logging in. Throughout this activity there will be two possible tracks you can take depending on the nature of your group of students, a more open track that will allow a bit more freedom and inquiry and a more guided version that will provide more structure.

- Guided version: In advance of class, create a vision for the class to refer to. Have students search for your vision and load it on their screen.
- Open version: Allow students to create the own vision - selecting any area in New York City that they would like to examine and defining their vision extent.

Once they have zoomed into the vision they are using, students can use the sliders on the left hand column of the screen to switch between a 1609 view and a modern view. This will allow them to observe the differences in ecosystems in their vision over the 400 years. If the students have made their own vision, they can also use the "Grid Inspector" tool on the right side of the screen, to more closely examine which ecosystems are present in the 1609 area and in the modern area. If you are using the guided version, the grid inspector tool will only be available if the students select "copy and edit" at the top of the screen to save a version of the vision as their own. Note that when using the grid inspector, there is a dropdown menu in the window that pops up to reveal the ecosystem, and this dropdown can be toggled between 1609, modern day, and the new vision. As students explore their vision, they should use the Vision Comparison Worksheet to note general observations about the two versions of their area as well as to record the advantages of each. What are the pros and cons of a more urban environment, versus a wilder environment?

Students should click on "recalculate"/"show details" to open the dashboard. Once there, students can compare the vision as it is today to how it was in 1609, examining a variety of data on the dashboard as well as in the data summary tab, and continuing to record their ideas about advantages of modern/urban vs. historic/wild. Students should also record data from Visionmaker to support each advantage. For example, if they think that more jobs is an advantage of modern day New York, they can record the number of jobs and/or the number of jobs per capita that they find in the Visionmaker data. This allows students to make their thinking clear, and to use data to make judgments about the pros and cons of each version of their area.

- Guided version: give students guidance on what data to examine. Suggestions would be to focus on the same data that they encountered in Activity 2, since that will have meaning for them already. Additionally, they could look at biodiversity, as that will be a significant change.
- Open version: let students fully engage in self-led inquiry, finding the data they are interested in and that has the most significance.

Students may note ideas such as: more people in urban environment, more workers/jobs, more hospitals, culture/stadiums, etc., more things to do, e.g. restaurants; more biodiversity in wild environment, more green space, less greenhouse gases, less stormwater runoff, less waste, etc.

Remind students that they should keep per capita numbers in mind as they compare – not just total number of jobs/workers, but relative to the number of people overall, for example.

Once the students have explored, observed, and recorded their thoughts on the changes to their vision over time, there is again an option, depending on your group of students, to allow them more freedom or to provide them more structure.

- Guided version: as a class, discuss the pros and cons that students noted from the vision. Select three parameters to focus on, either two advantages of urban and one advantage of wild, or two advantages of wild 1609 and one advantage of modern day. Between class sessions that you see these students, create a Challenge for them in Visionmaker. Use these three parameters as the foci for the Challenge. See instructions for issuing Challenges. The goal would be for students to create a vision where they maintain the advantages of urbanization while reintroducing the advantages of the wild landscape. For example, to maintain the high use of public transportation (personal miles by mode) and number of workers, while increasing the biodiversity to levels closer to those found in 1609.
- Open version: tell the students their next challenge is to edit their vision such that they maintain the advantages of urbanization while the incorporating/reintroducing the advantages of the wild/1609 landscape. Each group can choose two advantages of the urban landscape and two advantages of the wild landscape to focus on. Once they have selected their foci, they can proceed with this on their own without a formal Challenge in Visionmaker. You may want to check in with groups throughout this process to make sure they are clear and on track.

Challenges such as this are quite open ended and can be given more or less time to accomplish. Students should be given at least one class period, however more time, estimated up to four periods, will result in richer results. Once students have completed the redesigns of their visions, allow groups to share their work with one another, and discuss the different strategies and decisions they made. This can be informal or formal presentations. Additionally, an extension would be to have students write a paper discussing this activity – their understanding of urbanization, the pros and cons, the observations they made using Visionmaker, and the work they did to balance the tradeoffs of urbanization in New York City.

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Student Name: _____

Population Comparison Worksheet

Population of Earth: _____

Population of China: _____

Population of France: _____

Population of Brazil: _____

Population of Kenya: _____

Population of Australia: _____

Population of USA: _____

Population of New York State: _____

Population of your Home State: _____

Population of California: _____

Population of Wyoming: _____

Location a:

Percent of commuters who bike to work = 1
percent of commuters who take public transit to work = 11.1
Percent of commuters who walk to work = 3.7
Percent of commuters who drive to work = 77.3
Average travel time to work (minutes) = 29.2
Daily vehicle miles per capita = 22.7
Number of workers or jobs = 1,745,818
Average high temperature in July (°F) = 77
Average low temperature in January (°F) = 51
Average annual precipitation (inches) = 18.67
Average annual snowfall (inches) = 0
Water usage (gallons per person per day) = 98.6
Solid waste generated (pounds per person per day) = 11.24

Location b:

Percent of commuters who bike to work = 0.8
percent of commuters who take public transit to work = 56.2
Percent of commuters who walk to work = 10.1
Percent of commuters who drive to work = 27
Average travel time to work (minutes) = 39.4
Daily vehicle miles per capita = 15.44
Number of workers or jobs = 3760404
Average high temperature in July (°F) = 83
Average low temperature in January (°F) = 26
Average annual precipitation (inches) = 42.76
Average annual snowfall (inches) = 24
Water usage (gallons per person per day) = 66.84
Solid waste generated (pounds per person per day) = 2.3

Location c:

Percent of commuters who bike to work = 5.5
percent of commuters who take public transit to work = 1.3
Percent of commuters who walk to work = 9.5
Percent of commuters who drive to work = 77.9
Average travel time to work (minutes) = 14
Daily vehicle miles per capita = 26.47
Number of workers or jobs = 21,804
Average high temperature in July (°F) = 83
Average low temperature in January (°F) = 14
Average annual precipitation (inches) = 16.23
Average annual snowfall (inches) = 50
Water usage (gallons per person per day) = 102.78
Solid waste generated (pounds per person per day) = 9.66

Location d:

Percent of commuters who bike to work = 0.2
percent of commuters who take public transit to work = 2.8
Percent of commuters who walk to work = 1.4
Percent of commuters who drive to work = 90.3
Average travel time to work (minutes) = 25.8
Daily vehicle miles per capita = 31.1
Number of workers or jobs = 1,106,983
Average high temperature in July (°F) = 95
Average low temperature in January (°F) = 30
Average annual precipitation (inches) = 40.97
Average annual snowfall (inches) = 0
Water usage (gallons per person per day) = 98.05
Solid waste generated (pounds per person per day) = 9.27

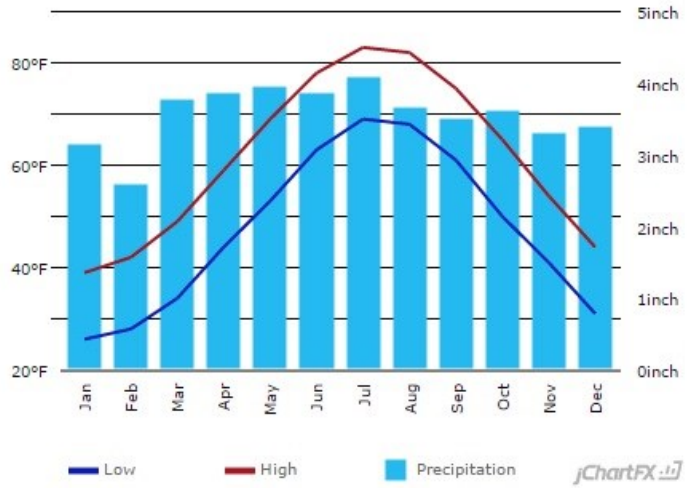
Location e:

Percent of commuters who bike to work = 1.7
percent of commuters who take public transit to work = 33
Percent of commuters who walk to work = 15.1
Percent of commuters who drive to work = 45.8
Average travel time to work (minutes) = 28.7
Daily vehicle miles per capita = 20.3
Number of workers or jobs = 317,930
Average high temperature in July (°F) = 81
Average low temperature in January (°F) = 22
Average annual precipitation (inches) = 43.76
Average annual snowfall (inches) = 44
Water usage (gallons per person per day) = 88.7
Solid waste generated (pounds per person per day) = 2.09

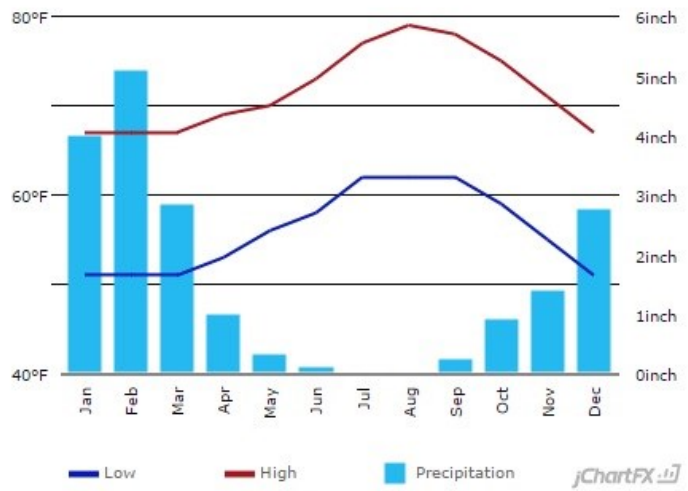
Location f:

Percent of commuters who bike to work = 1.3
percent of commuters who take public transit to work = 26.7
Percent of commuters who walk to work = 6.4
Percent of commuters who drive to work = 59.9
Average travel time to work (minutes) = 33.5
Daily vehicle miles per capita = 20.5
Number of workers or jobs = 1,213,901
Average high temperature in July (°F) = 84
Average low temperature in January (°F) = 17
Average annual precipitation (inches) = 36.88
Average annual snowfall (inches) = 37
Water usage (gallons per person per day) = 80
Solid waste generated (pounds per person per day) = 5.3

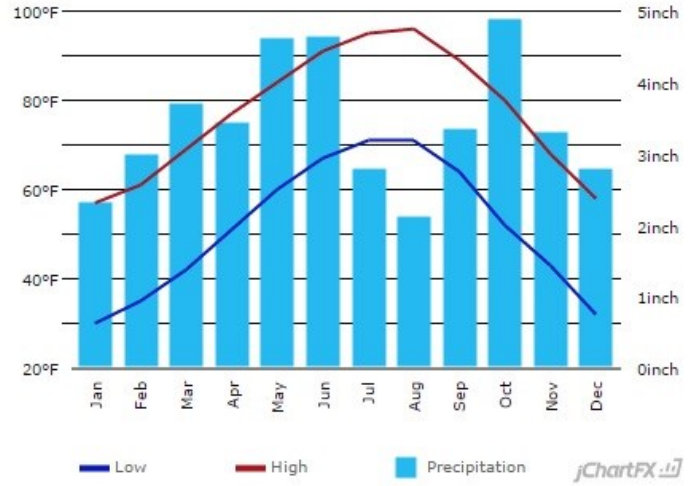
Location b:



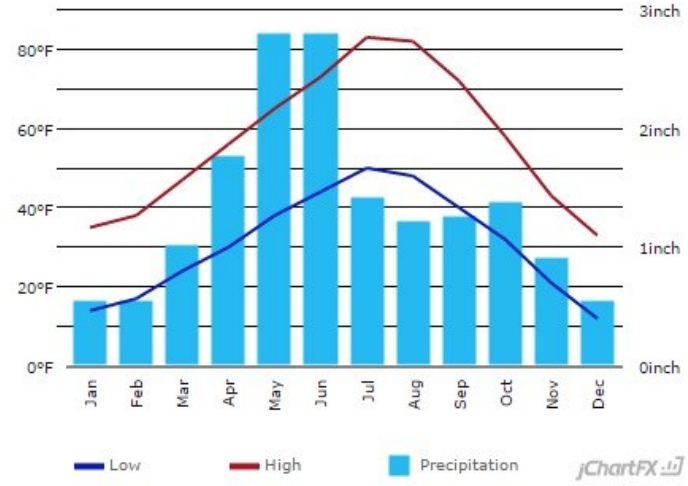
Location a:



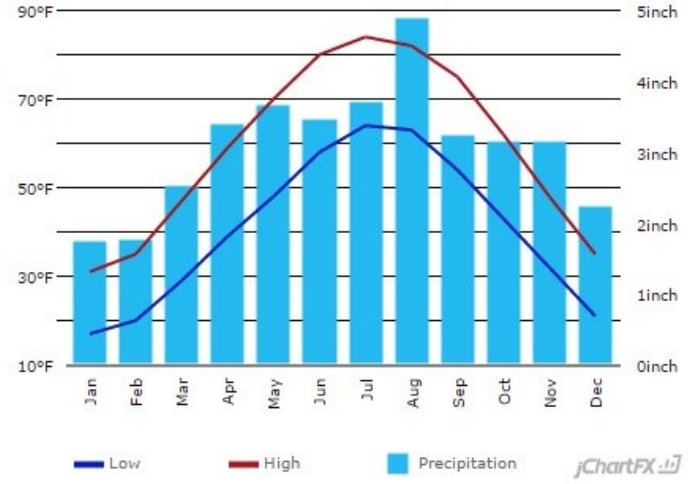
Location d:



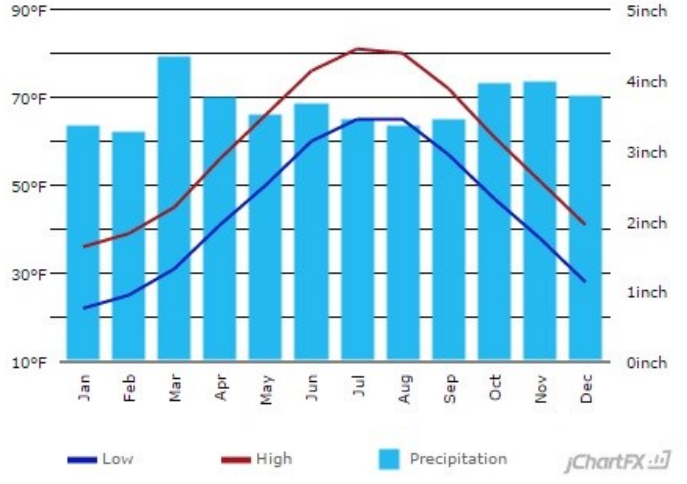
Location c:



Location f:



Location e:



Location 1:
Boston, Massachusetts

Residents = 667,137 people
Area = 48.28 square miles
Population Density =12,792.7 people/square mile

Location 2:
Bozeman, Montana

Residents = 43,405 people
Area = 19.12 square miles
Population Density = 1,950 people/square mile

Location 3:
Chicago, Illinois

Residents = 2,720,546 people
Area = 227.63 square miles
Population Density = 11,841.8 people/square mile

Location 4:
Dallas, Texas

Residents = 1,300,092 people
Area = 340.52 square miles
Population Density = 3517.6 people/square mile

Location 5:
Los Angeles, California

Residents = 3,936,940 people
Area = 468.67 square miles
Population Density = 8,092.3 people/square mile

Location 6:
New York City, New York

Residents = 8,550,405 people
Area = 302.64 square miles
Population Density = 27,012.5 people/square mile

ACTIVITY 2 - Teacher Answer Key

Location 1: Boston, MA = Location e

Location 2: Bozeman, MT = Location c

Location 3: Chicago, IL = Location f

Location 4: Dallas, TX = Location d

Location 5: Los Angeles, CA = Location a

Location 6: New York City, NY = Location b

Notes for teachers:

As population density increases, the percent of commuters who drive to work decreases, with the exception of Bozeman, MT which is very small, and the percent of commuters who take public transit increases.

As population density increases solid waste and water usage both tend to decrease. This is not a perfect correlation, but is a trend in the data.

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Student Name: _____

Evidence Worksheet

Argument:	Evidence:
Boston, MA Location 1 = Location ___	• • • •
Argument:	Evidence:
Bozeman, MT Location 2 = Location ___	• • • •
Argument:	Evidence:
Chicago, IL Location 3 = Location ___	• • • •
Argument:	Evidence:
Dallas, TX Location 4 = Location ___	• • • •
Argument:	Evidence:
Los Angeles, CA Location 5 = Location ___	• • • •
Argument:	Evidence:
New York City, NY Location 6 = Location ___	• • • •

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ACTIVITY 3 Images

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Vision Comparison Worksheet

Student Name: _____

Vision Name: _____

1609		Modern Day	
General Observations		General Observations	
Advantages	Evidence	Advantages	Evidence