

Population Dynamics Through Cemetery Data Analysis

Topic:

Population Dynamics

Standards Addressed:

Indiana

- 7.1.3 – Explain why it is important in science to keep honest, clear, and accurate records.
- 7.1.4 – Describe that different explanations can be given for the same evidence, and it is not always possible to tell which one is correct without further inquiry.
- 7.2.1 – Find what percentage one number is of another and figure any percentage of any number.
- 7.2.7 – Incorporate circle charts, bar and line graphs, diagrams, scatter plots, and symbols into writing such, as lab or research reports, to serve as evidence for claims and/or conclusions.
- 7.4.9 – Understand and explain that as any population of organisms grows, it is held in check by one or more environmental factors. These factors could result in depletion of food or nesting sites and/or increase loss to increased numbers of predators or parasites. Give examples of some consequences of this.
- 7.4.10 – Describe how technologies having to do with food production, sanitation, and disease prevention have dramatically changed how people live and work and have resulted in changes in factors that affect the growth of human population.
- 7.5.3 – Demonstrate how the scale chosen for a graph or drawing determines its interpretation.
- 7.5.4 – Describe that the larger the sample, the more accurately it represents the whole. Understand, however, that any sample can be poorly chosen and this will make it unrepresentative of the whole.
- 7.7.3 – Describe how physical and biological systems tend to change until they reach equilibrium and remain that way unless their surroundings change.

Objectives:

- Students will be able to define a population with regards to area, species and time
- Students will be able to calculate survivorship for a given population
- Students will be able to calculate mortality for a given population
- Students will be able to graph a survivorship curve from birth and death date data
- Students will be able to graph a mortality curve from birth and death date data
- Students will be able to explain the usefulness of large data sets and the limitations of small ones
- Students will be able to collect and analyze data in a scientific format
- Students will be able to use technology to graphically display mortality and survivorship of given populations

Materials Needed:

<u>Teacher</u>	<u>Student</u>
Copies of Data Sheet 1 for each student	Data Sheet 1
Copies of Data Sheet 2 for each student	Data Sheet 2
Sample morality and survivorship graphs	Pencil or Pen
Graph paper for each student	Calculator (optional)
Access to spreadsheet software	Walking shoes
Access to a large cemetery with a range of at least 150 years	

Lesson Introduction:

Population dynamics is a concept that is often taught through abstract thought often using classic examples that may have little relevance to students' experiences. This activity is designed to illustrate population dynamics using the human population.

A population is often defined as a particular group of individuals of the same species living in a defined area. Although this definition of a population is easy to comprehend, it assumes that populations are static, unchanging. That, of course, is not the case. A population changes over time and the population that existed in a particular area 100 years ago is certainly not the same population that exists today. This is as true for humans as it is for any other organism. Time, as a factor defining a population, needs to be introduced as part of the definition of a population to account for its dynamic existence. A new definition for a population emerges as a group of individuals of a particular species that live in a given area **at a particular time**.

Populations change in a number of ways throughout time and measuring all of the influences is impossible. However, the outcome of those changes is easily measured through analysis of survivorship or mortality. The human population in the late 1800's faced many challenges that modern technology and medicine have alleviated today. Childbirth, for instance, was a very dangerous and often deadly experience for women of the late 1800's. The rate of death from childbirth today is extremely low. The types of changes that have occurred to make childbirth safer have affected the survivorship of the population.

Measuring survivorship in a population is relatively easy with the right data. Survivorship can be calculated using the percent of individuals still alive at the end of a given age interval. For instance, if there are 100 individuals sampled and 10 of them died before reaching the age of 5, the survivorship for this population at that age interval is 90%. Ninety percent of the individuals sampled lived to at least the age of 5. Survivorship changes over time as new technologies, medicine, and social change arise.

The inverse of survivorship is mortality. Given the example above, if 10 individuals out of 100 died before the age of 5, the mortality rate would be 10%. Ten percent of the individuals sampled died before the age of 5. Both survivorship and mortality can be graphed with ease. The X-axis should be labeled as the age intervals, five year intervals seem to work well. The Y-axis should be labeled as the percent survivorship or mortality. XY Scatter graphs should be used when graphing with a spreadsheet program such as Microsoft Excel. Examples of survivorship and mortality graphs accompany this document as Graphs 1 and 2.

Procedures:

1. Introduce the definition of a population. Leading students through their understanding of what a population is can be helpful. Bridging from the understanding that a population of a city is 'x' number of people to how scientists define a population is an easy and relevant comparison for most students.
2. Discuss how changes in the environment and culture might affect a population over time.
3. Discuss some of the changes that have had an impact on the human population over the past 150 years. Medical, technological, agricultural, cultural, and political changes all make good models for change in a population. Talking about the interdisciplinary impacts on populations is a wonderful way to incorporate multidisciplinary curriculum. Getting other instructors involved in this project from other disciplines is very easy when discussing historical, political, sociological, and artistic influences on a particular culture; all of which shape the human population over time. Info Sheet 1 and Info Sheet 2 give some guiding questions to facilitate the transition between the definition of a population and the concepts of survivorship and mortality.
4. Introduce the students to the concept of survivorship and mortality. Define each and give some examples of how to calculate each. Discuss the relationship between survivorship and mortality and what data is needed to calculate both. Using examples of graphs is a useful way to give a visual representation to these two concepts. Examples of possible survivorship and mortality graphs accompany this document as Graphs 3-8.
5. Obtain permission from the cemetery to conduct this study. Most cemeteries will accommodate if assured that respect is given to those buried and those visiting in the cemetery. Obtain a map for a relatively large cemetery nearby the school that has a range of death dates at least 150 years. Determine the sections of that cemetery that the students will collect data from noting any special areas, such as veteran areas, that may impact the survivorship and mortality rates. Make sure that areas chosen represent a large data set, 100-200 individuals, for each of three death date intervals, approximately 50 years each. For example, if the cemetery dates back to 1850, three death date intervals can be established: 1850-1899, 1900-1949, and 1950 to present. Data will be collected based on the death date, not on the birth date.
6. Schedule enough time, 2-4 hours, for students to collect, individually or in groups, at least 30 individuals' birth years, death years, and sexes. Before going to the cemetery to collect data it may be useful to assign groups of students to particular death date intervals and sexes. With three death date intervals and two sexes, six possible groups come out easily. With many students participating, multiple areas of the cemetery may need to be used so that duplicate data is avoided as much as possible.
7. Collect the data from the cemetery. Data Sheet 1 can be used to collect the data.
8. Once the data has been collected, have students calculate survivorship and mortality for their individual data using Data Sheet 2.
9. Have students graph their individual survivorship and mortality data and compare it to others with the same sex and death date interval. Have students make judgments regarding the usefulness of their data analysis based on the small sample size they collected.
10. Combine the raw data for the class for each death date interval and sex. This can be done easily using a spreadsheet program. Have students make survivorship and mortality graphs of the class data. Have students make comparisons between their individual

graphs and the class data graphs. Have students draw conclusions about the affect of sample size on a study. A Microsoft Excel template has been included with this document for the calculations and graphing of survivorship as [Template 1](#).

11. Have students draw conclusions about how the human population in your area has changed over the past 150 years. Wrap-up the activity by revisiting the definition of a population and the importance of time in that definition.

Worksheets:

Data Sheet 1

Data Sheet 2

Graphs 1-8

Info Sheet 1

Info Sheet 2

[Template 1](#)

Closure:

The analysis and discussion created around the survivorship and mortality data provide a nice closure to the concept of population dynamics. It is important, however, that students make the connection that all populations of organisms are dynamic, not just humans.

Assessment:

Assessment can be completed in a number of ways within this activity. Teacher observation of student participation is the most basic way to assess student learning. Data sheets from the cemetery can be collected and graded for completion. Calculations of survivorship and mortality from the individual and class data can be collected and graded as well. The graphical output from the data can be easily assessed for completion and correctness. As well, student presentations and/or write-ups may be developed and graded.

Extensions:

If working with a group of students that are able to complete and analyze this study with relative ease, additional challenges may be introduced. Sections of the cemetery dedicated to specific populations (veterans, city leaders, specific ethnic groups, etc) may be used as a comparison to the general population. Often this becomes very interesting, especially when integrating information from other disciplines (history, sociology, politics, etc). Brighter students may also find that research on medical and technological milestones might shed light on why the human population changes over such a short period of time. Breaking down the death date intervals, if the cemetery is sufficiently large, would provide for more precise changes in survivorship and mortality to be considered. As well, determining single age instead of age range survivorship and mortality rates would provide a more precise understanding of how the population has changed.

Connections:

The multidisciplinary connections that can be made with this study are endless. Social sciences, history, art, politics, literature, agriculture, technology, etc. most assuredly affect the human population and have been at the root of change. All of these disciplines can easily be integrated to create a better understanding of the population of humans in that area within

the time intervals included. The appreciation for the individuals that lived and the challenges they faced during the past 150 is possible with a multidisciplinary approach to this activity.

Internet Resources:

- Check with your local cemetery to see if they have a website
- Look for your city records online

Data Sheet 1							
Death Year Range _____				Males or Females			
Death Year		Death Year		Death Year		Death Year	
Birth Year		Birth Year		Birth Year		Birth Year	
Age at Death =		Age at Death =		Age at Death =		Age at Death =	
Death Year		Death Year		Death Year		Death Year	
Birth Year		Birth Year		Birth Year		Birth Year	
Age at Death =		Age at Death =		Age at Death =		Age at Death =	
Death Year		Death Year		Death Year		Death Year	
Birth Year		Birth Year		Birth Year		Birth Year	
Age at Death =		Age at Death =		Age at Death =		Age at Death =	
Death Year		Death Year		Death Year		Death Year	
Birth Year		Birth Year		Birth Year		Birth Year	
Age at Death =		Age at Death =		Age at Death =		Age at Death =	
Death Year		Death Year		Death Year		Death Year	
Birth Year		Birth Year		Birth Year		Birth Year	
Age at Death =		Age at Death =		Age at Death =		Age at Death =	
Death Year		Death Year		Death Year		Death Year	
Birth Year		Birth Year		Birth Year		Birth Year	
Age at Death =		Age at Death =		Age at Death =		Age at Death =	
Death Year		Death Year		Death Year		Death Year	
Birth Year		Birth Year		Birth Year		Birth Year	
Age at Death =		Age at Death =		Age at Death =		Age at Death =	
Death Year		Death Year		Death Year		Death Year	
Birth Year		Birth Year		Birth Year		Birth Year	
Age at Death =		Age at Death =		Age at Death =		Age at Death =	
Death Year		Death Year		Death Year		Death Year	
Birth Year		Birth Year		Birth Year		Birth Year	
Age at Death =		Age at Death =		Age at Death =		Age at Death =	

Data Sheet 2: Calculations of Survivorship

Death Year Interval _____

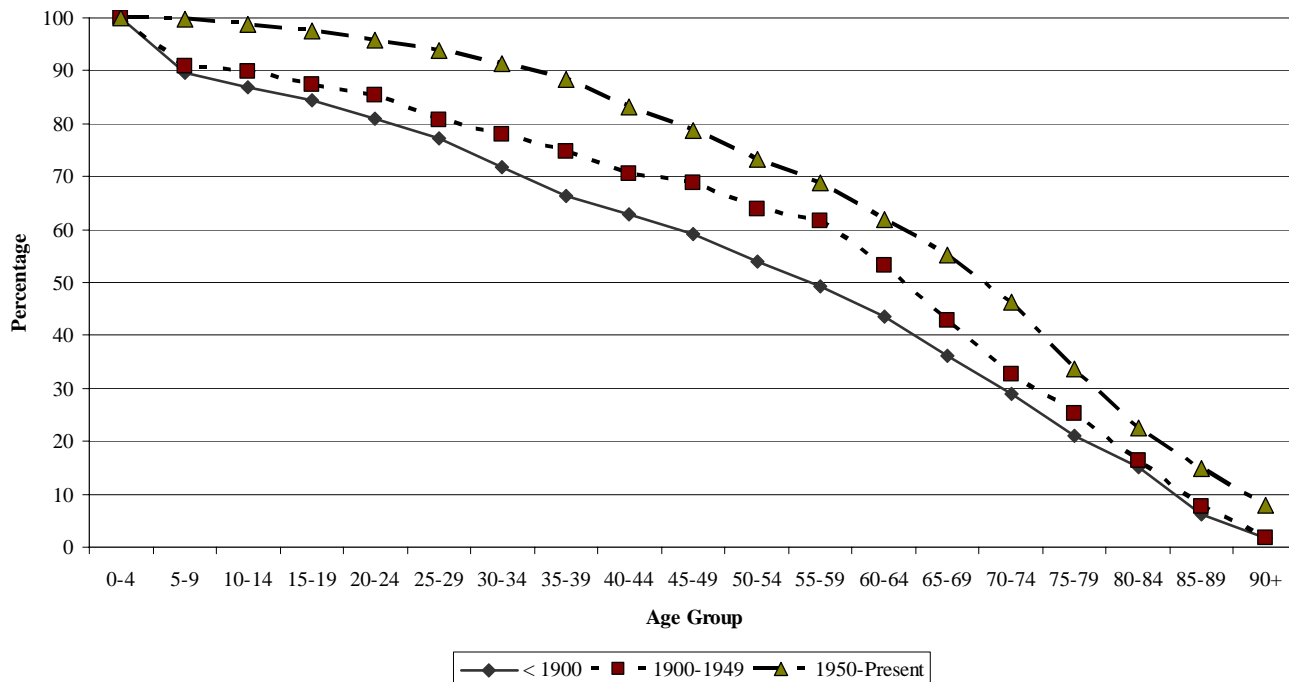
Male or Female

<u>Age in Years</u>	<u># of deaths per age interval</u>	<u># Alive at beginning of age interval</u>	<u>Survivorship</u>
0-4		Total = _____	1.00 (by definition)
5-9			
10-14			
15-19			
20-24			
25-29			
30-34			
35-39			
40-44			
45-49			
50-54			
55-59			
60-64			
65-69			
70-74			
75-79			
80-84			
85-89			
90+			

Total = _____ **copy this number above where indicated**

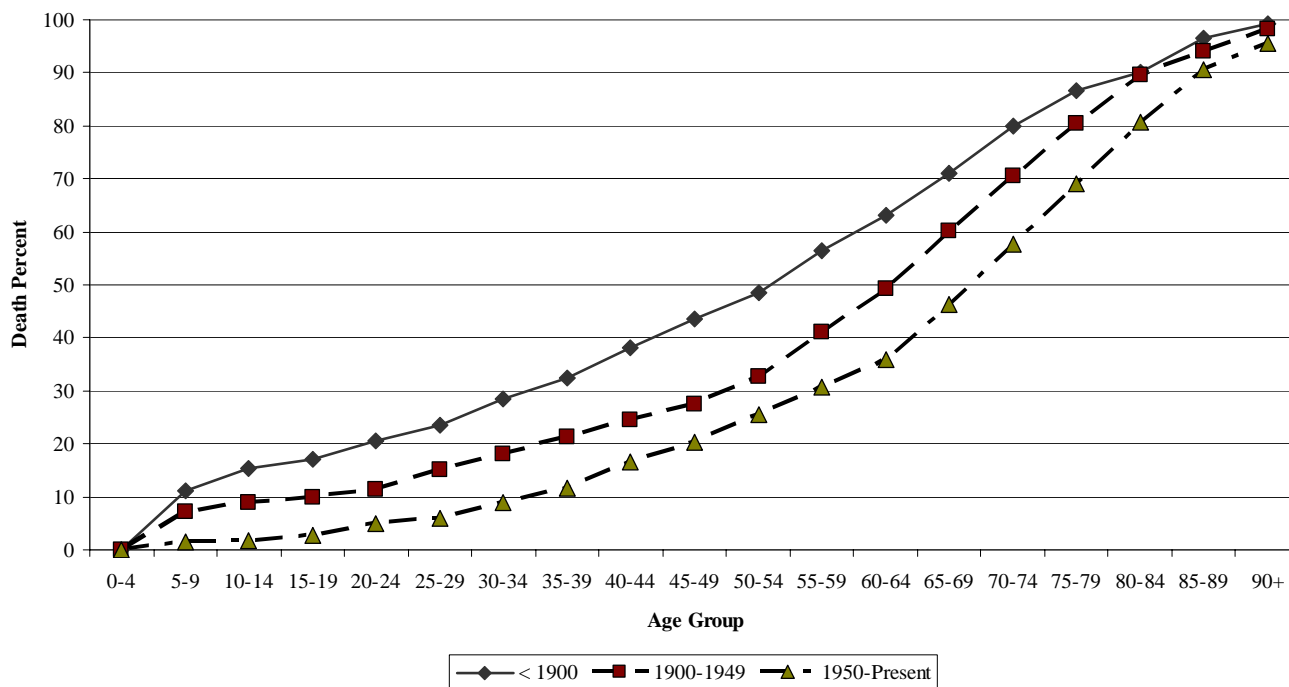
Female Survivorship Percentage

Graph 1



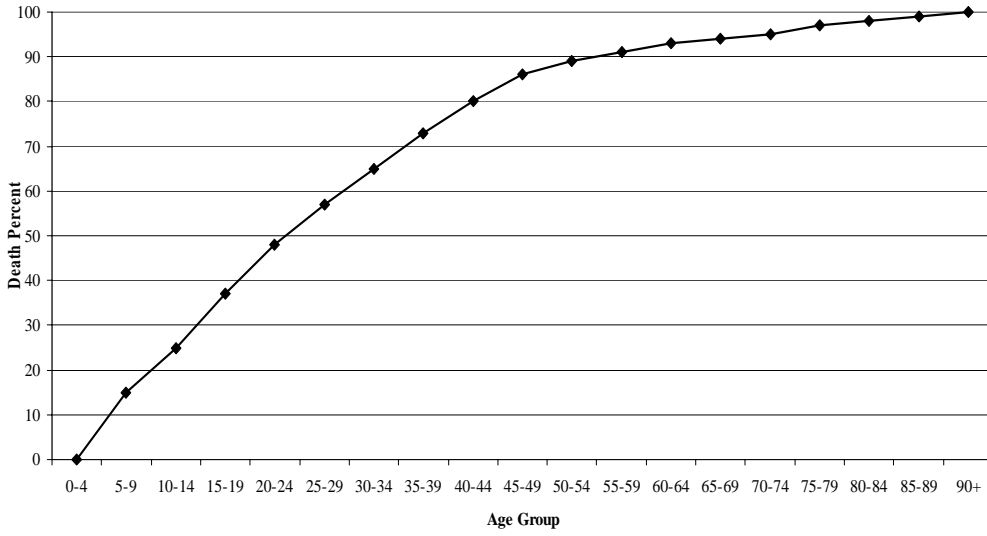
Male Mortality Percentage

Graph 2



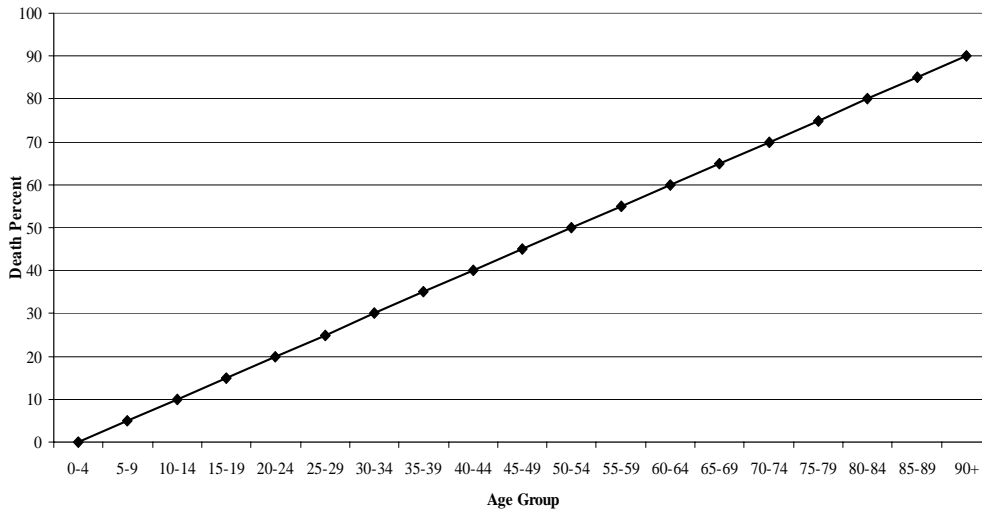
Graph 3

Mortality



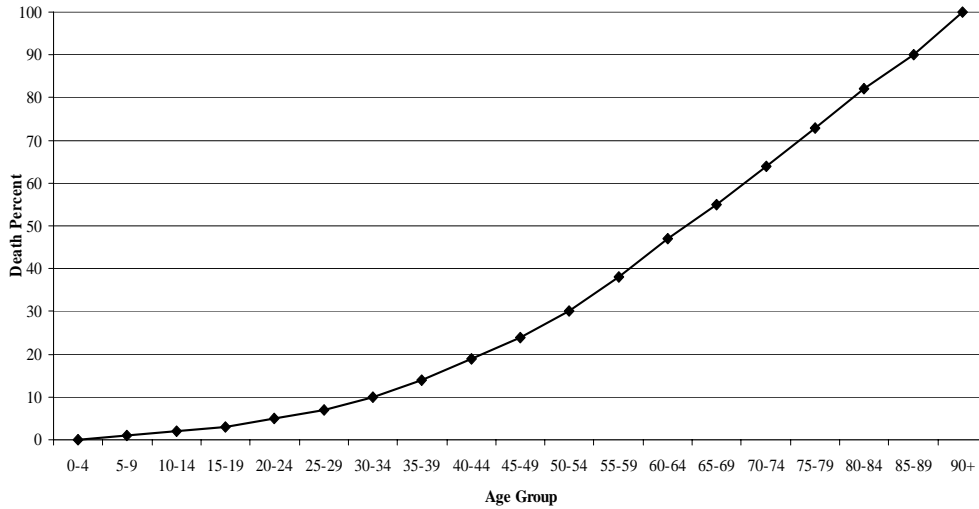
Graph 4

Mortality



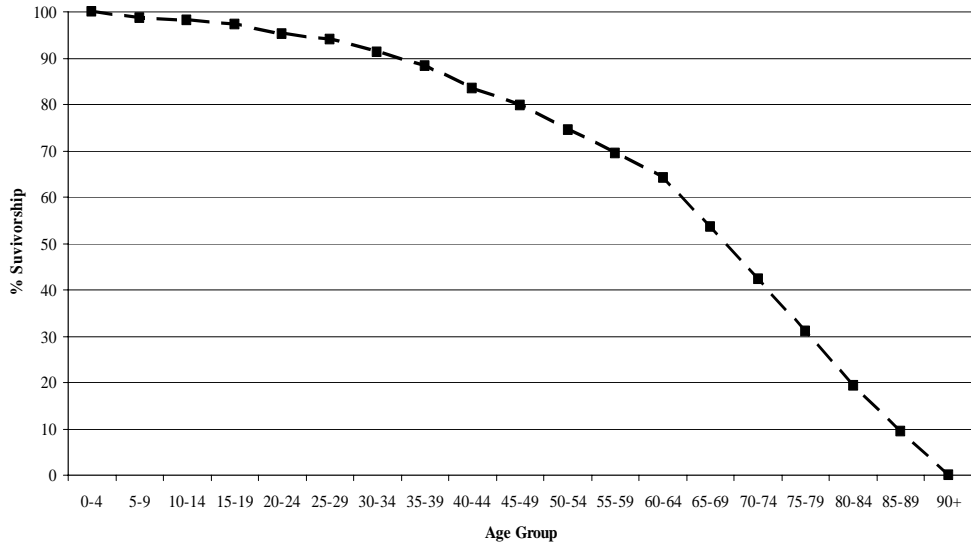
Graph 5

Mortality



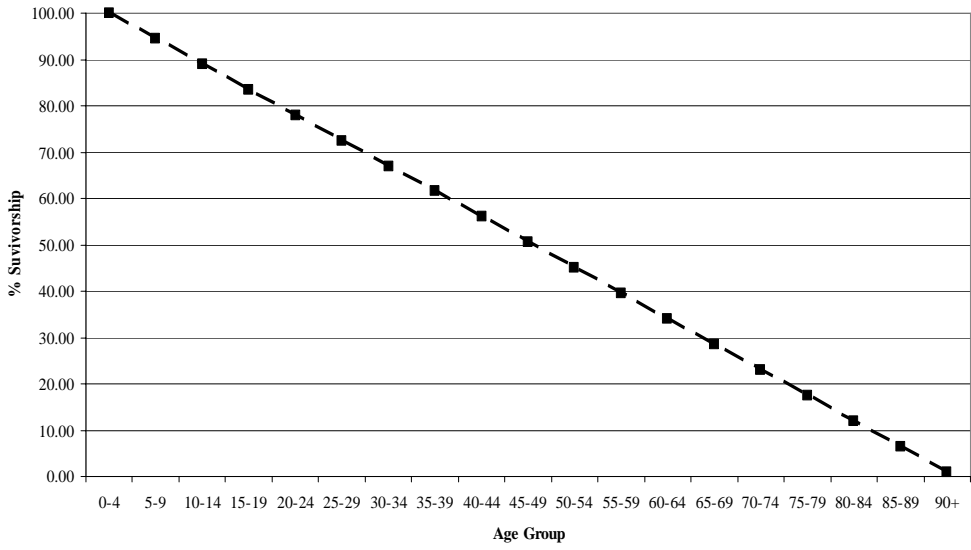
Survivorship

Graph 6



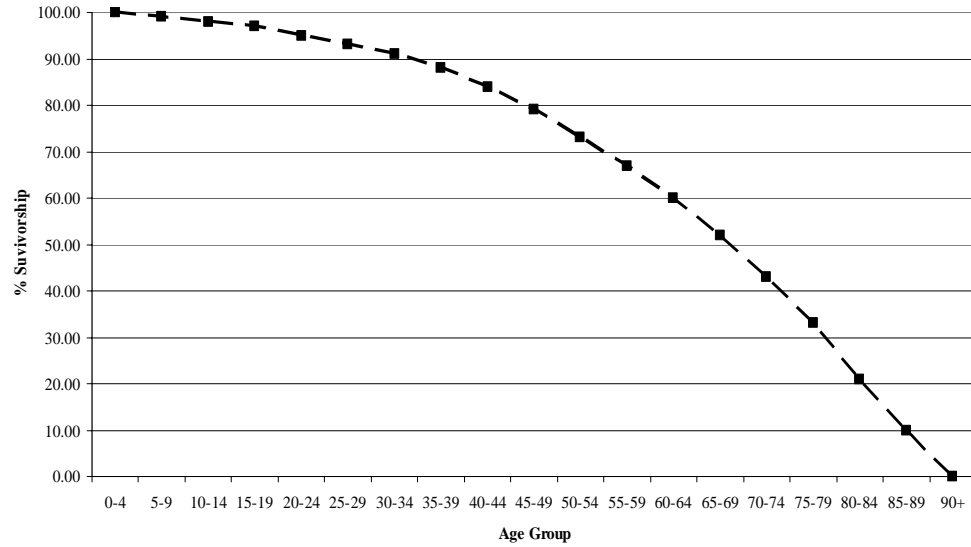
Survivorship

Graph 7



Survivorship

Graph 8



Info Sheet 1

Guiding Questions

Someone define a population for us.

A group of organisms of the same species that live in a particular area...(at a particular time) ← to be added later

Let's define our area. What if we changed our definition to include only those individuals who live or lived in our area? How would that change our definition?

Population - A group of humans that live or have lived in Indianapolis.

Is there anything else that we need to add to make our population more specific?

Introduce the concept of time as part of the definition of a population.

Have all human populations been the same throughout time?

Of course not. 200 years ago many factors that influenced the population are not present today.

What type of factors do you think have made a difference in our local population over the past 200 years? On a sheet of paper, list two factors that you think influenced our population the most.

After completing this, share those with your partner. Then come up with at least one more that you do not have listed already.

Immigration

Emigration

Disease

Technology

Physical space

Food scarcity/availability

Natural Disasters

Medicine

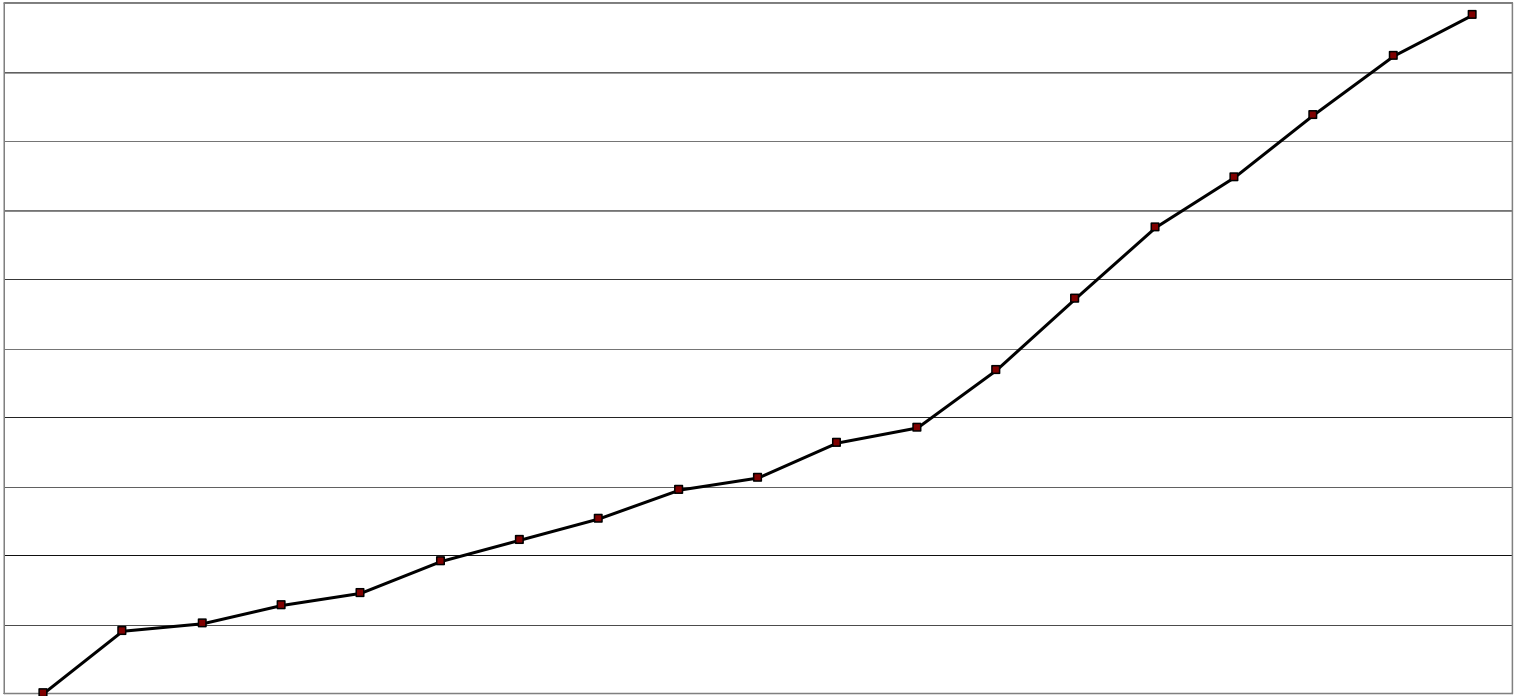
Education

Culture

Economics

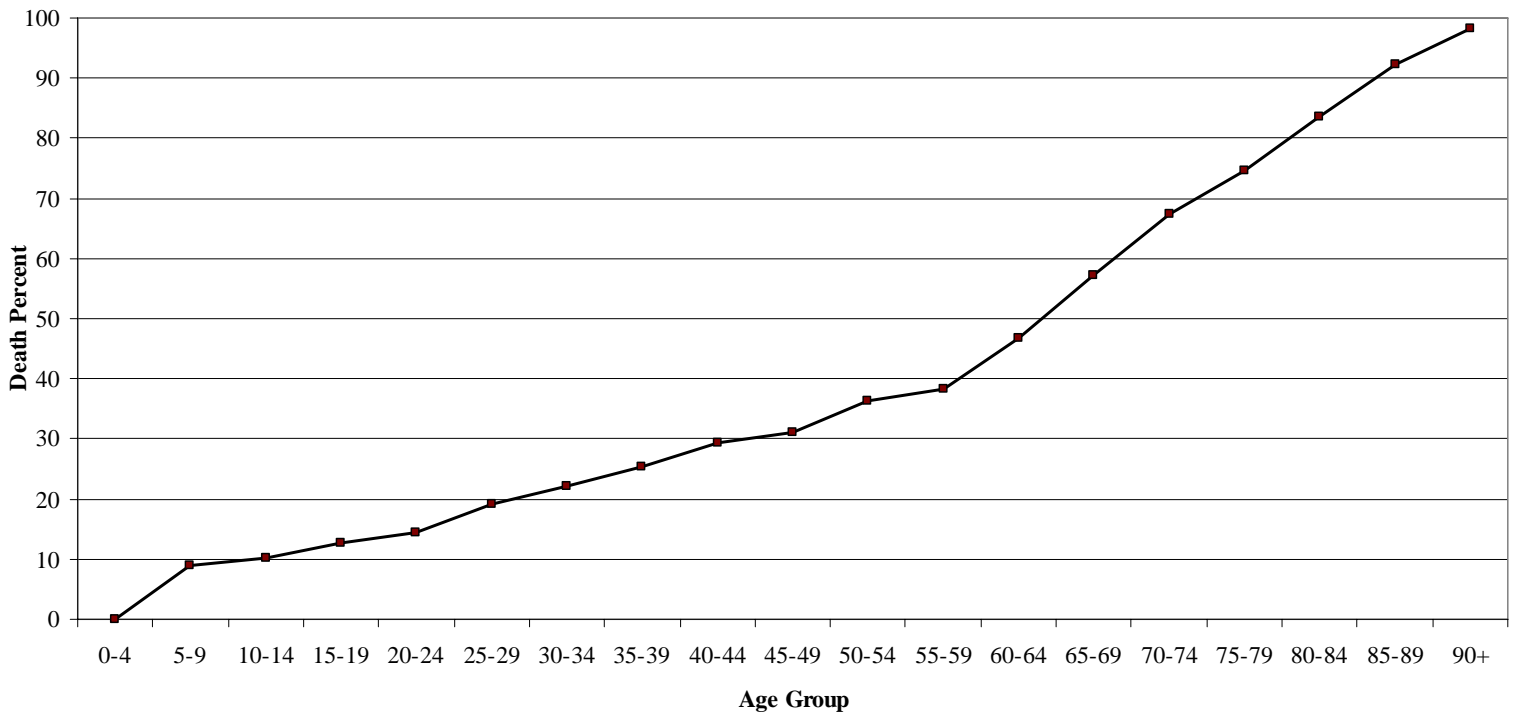
Populations are not static, not even the human population. Over time, a population changes due to changes in the culture, societal values, and technology. Next week, we will continue looking at the human population and how we as young scientists can look at how the local population has changed over the past 200 years.

Info Sheet 2



What conclusions can we draw from this graph in general?

What can we say specifically about this graph?



What conclusions can we draw from this graph in general now?

What can we say specifically about this graph now?

Think about what this graph says in relation to our current definition of a population.
 What is our current definition of a population?

Where might we get information about people who lived in our area in 1825?

What kind of data do we need to find out how old people were when they died in 1825?

If we had all of the age data for all of the people who lived in our area in 1825, what kind of things could we show in a graph?

In a few days we will be going to _____ Cemetery where we will begin collecting data on how old people in Indianapolis were when they died. We will be looking at 3 populations of humans: those that died between before 1900, 1900-1949, and 1950-present. We will be calculating survivorship, the percentage of people still alive at a particular age, and mortality, the percentage of people **not** alive at a particular age. We will need to think about what we might find before collecting the data, however.

What types of patterns or trends do you think we will find in our 3 populations with regards to survivorship, the percentage of people still alive at a particular age?

What types of patterns or trends do you think we will find in our 3 populations with regards to mortality, the percentage of people **not** alive at a particular age?

Sketch 4 graphs showing the trends you think you will see regarding survivorship for each of the 3 populations.

Sketch 4 graphs showing the trends you think you will see regarding mortality for each of the 3 populations.

Make a hypothesis for each of six graphs that relates to what you have drawn.

1. _____
2. _____
3. _____
4. _____
6. _____