Andersonville

National Park Service
U.S. Department of the Interior

Andersonville National Historic Site
Andersonville National Cemetery

August Anguish at Andersonville

Andersonville Prison as it appeared in August 1864 with 33,000 prisoners.
NPS/A.J. Riddle

A Mathematical Analysis of Andersonville's Worst Month

Produced by Andersonville National Historic Site
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Produced by the Division of Interpretation and Education
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Suggested Age: 4-12 Grade

Objectives (4th -6th Grade): At the end of the lesson, students will be able to do one or more of the following:
-Students will be able to determine the area of a rectangle.
-Students will understand that a/b = a ÷ b.
-Students will be able to convert fractions to percentages.

Objectives (7th-8th Grade): At the end of the lesson, students will be able to do one or more of the following:
-Determine the mean, median, and mode from a given set of data.
-Calculate and compare ratios from a given set of data.

Objectives (9th-12 Grade) At the end of the lesson, students will be able to do one or more of the following:
-Use the Pythagorean Theorem to solve problems.
-Convert from one unit of measurement to another.
-Apply appropriate mathematical strategies to solve problems.

Materials: Consolidated Monthly Returns, August 1864
Map of Andersonville
Daily Returns, August 1864

Common Core Standards

CCGPS Mathematics (4th Grade) CC4.MD.1 Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two column table. For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), ...

CCGPS Mathematics (5th Grade) MCC5.NF.3 Interpret a fraction as division of the numerator by the denominator (a/b = a ÷ b). Solve word problems involving division of whole numbers leading to answers in the form of fractions or mixed whole numbers leading to answers in the form of fractions or mixed numbers, e.g., by using visual fraction models or equations to represent the problem. For example, interpret ¾ as the result of dividing 3 by 4, noting that ¾ multiplied by 4 equals 3, and that when 3 wholes are shared equally among 4 people each person has a share of size ¾. If 9 people want to share a 50-pound sack of rice equally by weight, how many pounds of rice should each person get? Between what two whole numbers does your answer lie?

CCGPS Mathematics (6th Grade) MCC6.RP.3 Use ratio and rate reasoning to solve real world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

CCGPS Mathematics (7th Grade) MCC7.EE.2 Understand that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related. For example, a + 0.05a = 1.05a means that “increase by 5%” is the same as “multiply by 1.05.”

CCGPS Mathematics (8th Grade) MCC8.F.4 Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a change and initial value of the function from a description of a relationship or from two (x,y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

Common Core Standards (Continued)

CCGPS Mathematics I (9-12) MM1D3. Students will relate samples to a population.
a. Compare summary statistics (mean, median, quartiles, and interquartile range) from one sample data distribution to another sample data distribution in describing center and variability of the data distributions.
b. Compare the averages of the summary statistics from a large number of samples to the corresponding population parameters. c. Understand that a random sample is used to improve the chance of selecting a representative sample.

CCGPS Mathematics (9-12) MM1G3. Students will discover, prove, and apply properties of triangles, quadrilaterals, and other polygons.
a. Determine the sum of interior and exterior angles in a polygon.
b. Understand and use the triangle in equality, the side-angle inequality, and the exterior-angle inequality.
c. Understand and use congruence postulates and theorems for triangles (SSS, SAS, ASA, AAS, HL).
d. Understand, use, and prove properties of and relationships among special quadrilaterals: parallelogram, rectangle, rhombus, square, trapezoid, and kite.
e. Find and use points of concurrency in triangles: incenter, orthocenter, circumcenter, and centroid.

CCGPS Mathematics II (9-12) MM2D1. Using sample data, students will make informal inferences about population means and standard deviations.
a. Pose a question and collect sample data from at least two different populations.
b. Understand and calculate the means and standard deviations of sets of data.
c. Use means and standard deviations to compare data sets.

CCPGS Mathematics II (9-12) MM2P1. Students will solve problems (using appropriate technology).
a. Build new mathematical knowledge through problem solving.
b. Solve problems that arise in mathematics and in other contexts.
c. Apply and adapt a variety of appropriate strategies to solve problems.
d. Monitor and reflect on the process of mathematical problem solving.

In addition, this lesson incorporates several more Common Core Georgia Performance Standards that can be found at the following web addresses:

https://www.georgiastandards.org/standards/Pages/BrowseStandards/GPS_by_Grade_Level_K-8.aspx
https://www.georgiastandards.org/Standards/Pages/BrowseStandards/MathStandards9-12.aspx

VOCABULARY

4th Grade-6th Grade	7th-8th Grade	9th-12th Grade
Fraction	Ratios	Representative Sample
Numerator	Mean	Mortality Rate
Denominator	Median	Statistics
	Mode	Linear Functions

Background Information

After the breakdown of the prison exchange system in mid 1863, both Union and Confederate forces were forced to hold prisoners for an extended period of time. The Confederacy first held Union prisoners in the capital city of Richmond, VA, but this placed a tremendous strain on the city's resources. So in early 1864 the Confederacy built a new prison in rural Georgia – Camp Sumter, which quickly became known as Andersonville.

By the summer of 1864 Andersonville was incredibly overcrowded. Approximately 33,000 prisoners were held in a space intended for 10,000 and diseases related to sanitation and nutrition were rampant. By the time the prison ceased operation 45,000 men passed through the prison gates, and 13,000 of them died, making Andersonville the deadliest ground in American history.

It can sometimes be difficult for students to grasp to scale of suffering at Andersonville. This activity provides an opportunity for students to apply math skills and get a better sense of the overcrowding and death that occurred in August of 1864, when the prison was at its maximum population.

Lesson Procedure

1. Suggested Introductory Activities
   a. visit www.nps.gov/ande/forteachers And select one or more lesson plan activities to introduce your students to Andersonville.
   b. request a copy of "Voices from Andersonville," a 30 minute introductory film to the Andersonville story

2. Review with students the appropriate mathematical skills that they will need.

3. Students may work individually or in groups. Distribute to each student or group a copy of the age appropriate worksheet.

   4th-6th Grade: "The Size & Scale of Andersonville"
   7th-8th Grade: "The Statistics of Death at Andersonville"
   9th-12th Grade: Analyzing the Data: Understanding the Suffering at Andersonville Prison

For older or advanced students, you may assign lower grade level activities.

4. Distribute copies to each student or group copies of the following:
   - "Map of Andersonville Prison"
   -"Daily Returns, August 1864
   - "Consolidated Monthly Return, August 1864"

5. Give students time to work through the assignment.

6. Using your answker key, go over the procedures with the students and help them solve each of the problems.

7. Discuss with students what these statistics mean.
   - How do you think it would feel to be a prisoner with so much death and suffering all around you?
   - Why do you think diseases were so prevalent at Andersonville?
   - Andersonville Prison was open for 14 months, and during that time 12,920 prisoners of war died in captivity there. August represents just a 31 day period.
   Do you think that the prison got better or worse? Do you think August was probably the worst time at Andersonville?

8. Have students complete the extension activites.

9. If time permits, consider taking a field trip to Andersonville. Information about field trips can be found at www.nps.gov/ande/forteachers

The Size & Scale of Andersonville

(1): How many prisoners died in the month of August? You can use the chart "Daily Returns, August 1864" and add the number of deaths for each day.

(2): What was the total square footage of Andersonville Prison before it was expanded? And after?

* 1 acre = 43,560 square feet.

Before expansion – 16 acres, after expansion – 26.5 acres.

(3): What fraction of the total prison population tried to escape during August? Express your answer as both a fraction and percent. To calculate attempted escapes, use the "Daily Returns, August 1864"

a. Divide the number of escapes by the number of total prisoners on hand in August.
b. Multiply the number found in step "a" by 100 to get the percentage.

(4): What fraction of escape attempts was successful? What percent?
Students can use the chart labeled "Daily Returns, August 1864"

A successful escape is defined as a prisoner that escapes but avoids recapture.

a. To calculate the successful escapes, add the number of recaptured prisoners, and subtract these from the total number of escapes.
b.Divide the number of successful escapes by the number of attempted escapes.
c. Multiply the number found in step "b" by 100 to get the percentage of escapes that were successful.

Andersonville Prison, as it appeared in August of 1864
NPS/AJ Riddle

The Statistics of Death at Andersonville

1. In the month of August, what was the mean number of prisoners that died daily? To calculate this, divide the total number of prisoner deaths in August by the number of days in august. Use the data found on the Consolidated Monthly Returns, August 1864

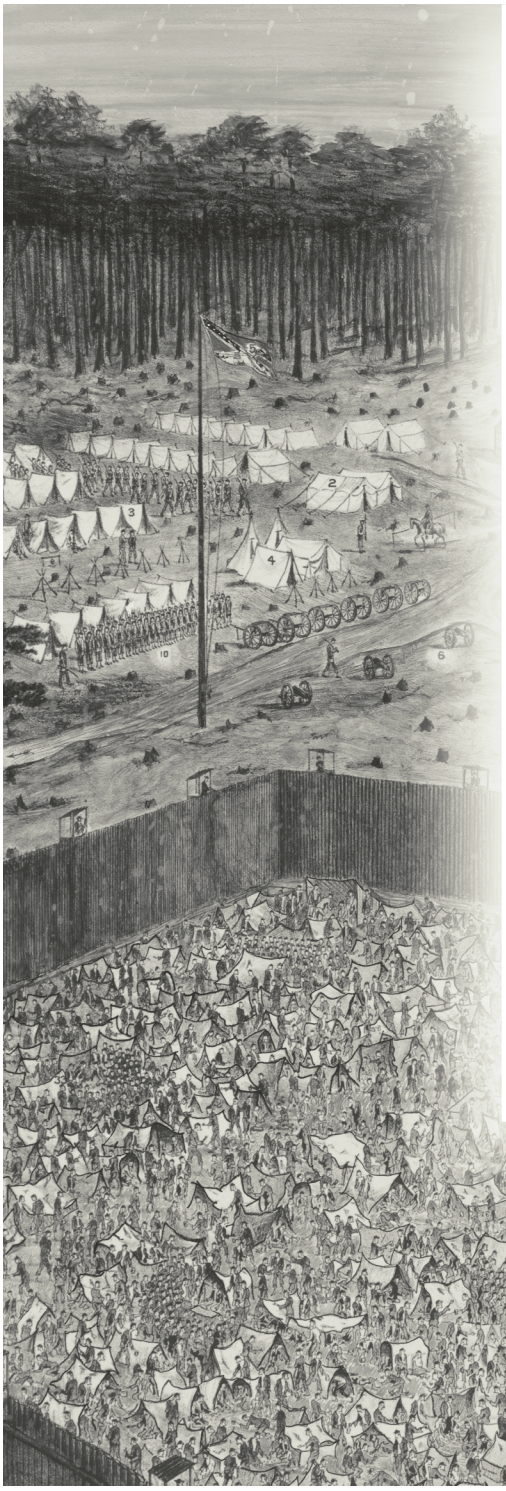
2. Using the daily returns from August 1864, calculate the median number of deaths. Going from least to greatest, list all daily death totals for prisoners. Find the middle number in this row of numbers.

3. In the month of August, what is the mode number of daily prisoner deaths? To calculate this use the daily returns from August 1864. Going from least to greatest, list all daily death totals for prisoners. Determine the number that appears most often.

4. What is the ratio of daily totals of prisoners on hand to the daily number of deaths? List the ratios in order from August 1 to August 31. Note any trends in the increase or decrease of the ratios. Use to daily returns from August 1864.
A. Divide both the number of prisoners that died and the grand total number of total prisoners each by the number of prisoners that died. For example: for August 1, you would divide 74 (the number that died) by 74, and 31,678 (the grand total) by 74. This would give you a ratio of 1:428 (1 death for every 428 prisoners on that particular day).
B. List the ratios for each day and discuss any trends.

Burying the Dead
Detail From a Lithograph by Andersonville Prisoner Thomas O'Dea

Analyzing the Data:
Understanding Suffering at Andersonville Prison



1. Using the Pythagorean Theorem and the map of the prison site, calculate the distance between the northeast corner and the southwest corner of the prison site.

2. If the total population of the prison increased by 10% on September 1st, what would the new population be? If on September 1st there was a prisoner uprising and the guards opened fire with rifles and cannons killing 25% of the prisoners and severely injuring 10% of those who were not immediately killed, then what would the new population be and how many prisoners would need medical attention?

3. Assuming that each prisoner would have needed 48 square feet (the standard size of modern jail cells) to survive the month of August, what would the new dimensions of the prison need to be? Express your answer in square feet and acres. Use the number of prisoners on hand on August 1st found in the Consolidated Monthly Return to solve this problem. 1 acre = 43,560 square feet

4. If a particular virus infected the prison population and had a 100% mortality rate, then how many days would it take for 50% of the total population to die? Use the population of the prison as of August 31st and assume that no more prisoners are added to the population because of the virus outbreak. Also, assume that once a prisoner is contagious he has 24 hours to live and will infect exactly two more prisoners before death.

Lithograph of Andersonville Prison, August 1864
Thomas O'Dea

Consolidated Monthly Returns - August 1864

National Park Service
U.S. Department of the Interior

Andersonville National Historic Site
Andersonville National Cemetery

Prisoners on hand on 1st of August, 1864:

In camp	29,985
In hospital	1,693
TOTAL	31,678
Received from various places during August	3,078
Recaptured	4
TOTAL	3,082
TOTAL (prisoners living during August)	34,760
Died during the month of August	2,993
Sent to other posts	23
Exchanged	21
Escaped	30
TOTAL	3,067
GRAND TOTAL (prisoners on hand on 31st of August)	31,693

Of which there are on the 31st of August:

In camp	29,473
In hospital	2,220
TOTAL	31,693

The Prison Grounds

National Park Service
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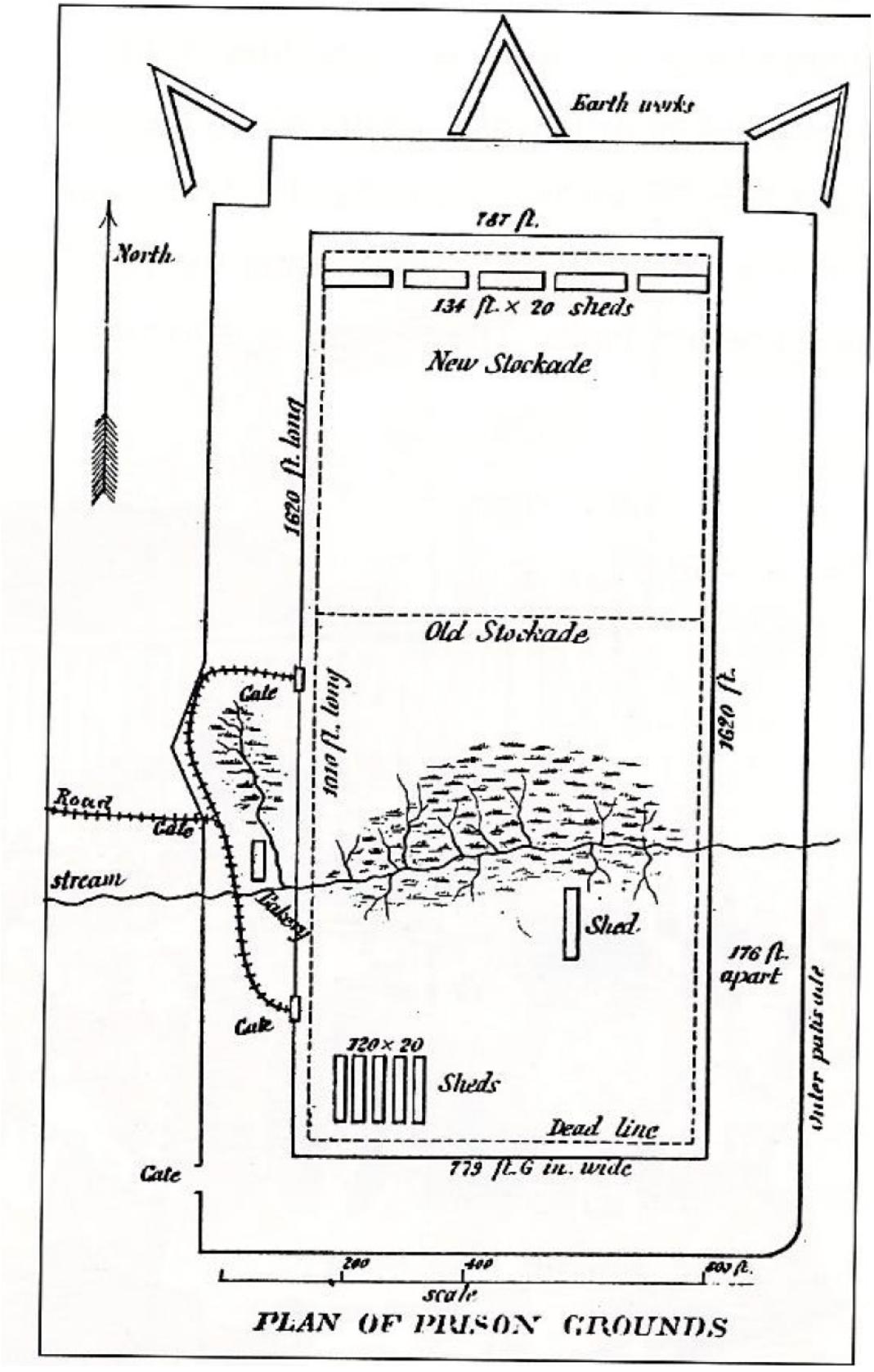

PLAN OF PRISON GROUNDS

Daily Returns, August 1864

National Park Service
U.S. Department of the Interior

Andersonville National Historic Site
Andersonville National Cemetery

Date	Received	Recaptured	Total Received	Total in prison stockade	Total in Hospital	Grand Total*	Escaped	Died	Paroled, Rleased, Exchanged	Sent to other prisons	Total Escaped, Transferred, died	In prison stockade	In Hospital	Total on Hand
1-Aug	0	0	0	29985	1693	31678	0	74	0	0	74	29985	1619	31604
2-Aug	42	0	42	29851	1753	31646	0	73	0	0	73	29893	1680	31573
3-Aug	1075	2	1077	29782	1791	32650	0	75	0	0	75	30859	1716	32575
4-Aug	220	0	220	29976	2599	32795	1	74	0	0	75	30195	2525	32720
5-Aug	1	0	1	30147	2573	32721	0	90	0	0	90	30148	2483	32631
6-Aug	174	0	174	29778	2843	32805	0	103	0	0	103	29962	2740	32702
7-Aug	82	0	82	29954	2748	32784	0	71	0	0	71	30026	2687	32713
8-Aug	59	0	59	29994	2719	32772	0	95	0	0	95	30053	2624	32677
9-Aug	329	0	329	29958	2719	33006	4	95	21	0	120	30262	2624	32886
10-Aug	3	0	3	30230	2656	32889	0	85	0	1	86	30232	2571	32803
11-Aug	169	0	169	29984	2613	32766	0	103	0	0	103	30359	2510	32869
12-Aug	123	1	124	30359	2510	32993	1	81	0	0	82	30439	2472	32911
13-Aug	4	0	4	30390	2521	32915	0	109	0	2	111	30390	2412	32804
14-Aug	55	0	55	30305	2499	32859	0	114	0	0	114	30360	2385	32745
15-Aug	16	0	16	30303	2440	32759	0	120	?	?	?	?	?	32639
16-Aug	4	0	4	30179	2460	32643	0	107	?	?	?	?	?	32536
17-Aug	22	0	22	30083	2453	32558	1	114	?	?	?	?	?	32443
18-Aug	17	0	17	30026	2417	32460	0	88	?	?	?	?	?	32372
19-Aug	8	0	8	29939	2433	32380	0	101	?	?	?	?	?	32279
20-Aug	26	0	26	29864	2415	32305	0	107	?	?	?	?	?	32198
21-Aug	?	?	?	29828	2370	32198	0	86	?	?	?	?	?	32112
22-Aug	130	0	130	29734	2380	32244	5	122	0	0	127	29859	2258	32117
23-Aug	99	0	99	29717	2400	32216	0	127	0	0	127	29816	2273	32089
24-Aug	27	0	27	29742	2365	32134	9	102	0	0	111	29760	2263	32023
25-Aug	29	0	29	29685	2335	32052	1	98	0	11	110	29702	2240	31942
26-Aug	162	0	162	29698	2344	32204	0	103	0	7	110	29753	2241	31944
27-Aug	3	0	3	29572	2322	31997	2	93	1	0	96	29672	2229	31901
28-Aug	32	1	33	29597	2304	31934	1	90	0	0	91	29629	2214	31843
29-Aug	80	0	80	29524	2318	31922	2	105	?	?	?	?	?	31815
30-Aug	48	0	48	29518	2297	31863	3	95	?	?	?	?	?	31764
31-Aug	20	2	22	29453	2312	31787	0	92	?	?	?	?	?	31693

* Grand Total includes “Total on Hand” and “Died”

Extension Activities

President Abraham Lincoln
Library of Congress

1. Students should imagine themselves as prisoners at Andersonville. Their job is to write a letter to Abraham Lincoln describing the conditions they are forced to live in and giving a detailed report of prisoner numbers (in the hospital, deaths per day, etc.) and living space (dimensions of the prison and square feet per prisoner) using the Consolidated Returns of the Month of August.

Angola Prison
Luisiana Department of Corrections

2. Angola prison in Louisiana (the largest maximum security in the United State) houses 5,000 inmates and occupies approximately 18,000 acres (not all of this acreage is used entirely for the prisoners). Andersonville held nearly 32,000 prisoners and occupied 26.5 acres. Calculate the two different prisoner-to-acre ratios and compare them.

The Size & Scale of Andersonville

Teacher's Guide & Answer Key

(1) How many prisoners died in the month of August? 2,993 died in the month of August

(2) What was the total square footage of the prison before it was expanded? And after?

There are 43,560 square feet per 1 acre.

16 acres x 43,560 sq. ft. = 696,960 sq. ft. before the expansion

26.5 acres x 43,560 sq. ft. = 1,154,340 sq. ft. after the expansion

(3) What fraction of the total prison population tried to escape during August? What percent?

30 total prisoners tried to escape in August

34,760 is the total number of prisoners that lived at the prison during August.

30/34,760 is the fraction of the prison population that tried to escape. This fraction reduces to

approximately 1/1,158.

30/34,760 expressed as a percentage is 0.0863% (less than 0.1% of all prisoners escaped)

(4) What fraction of escape attempts was successful? What percent?

30 escape attempts were made, and 6 were recaptured, meaning that 24/30 escapes of were successful.

26/30 is the fraction of escape attempts that were successful (13/15 if reduced).

26/30 expressed as a percentage is

The Statistics of Death at Andersonville

Teacher's Guide and Answer Key

(1) In the month of August, what was the mean number of prisoners that died daily? 2,993 prisoners died in the month of August. There are 31 days in August. 2,993 total deaths in August ÷ 31 days in August = 96.54 is the average number deaths per day.

(2) Using the daily death totals of prisoners in the month of August, find the median. The median (the middle number in a set of numbers listed from least to greatest) is 95.

(3) In the month of August, what is the mode number of daily prisoner deaths? The mode (the number that occurs most often) is 103.

(4) What is the ratio of daily grand totals of prisoners to the daily number of deaths? Note any trends in the increase or decrease of the ratios.

A. The ratios below are prisoner deaths to grand total (prisoner deaths:grand total)

August 1, 1:428
August 2, 1:434
August 3, 1:435
August 4, 1:443
August 5, 1:364
August 6, 1:318
August 7, 1:462
August 8, 1:345
August 9, 1:347
August 10, 1:387
August 11, 1:318
August 12, 1:407
August 13, 1:302
August 14, 1:288
August 15, 1:273
August 16, 1:305
August 17, 1:286
August 18, 1:369
August 19, 1:321
August 20, 1:302
August 21, 1:374
August 22, 1:264
August 23, 1:254
August 24, 1:315
August 25, 1:327
August 26, 1:313
August 27, 1:344
August 28, 1:355
August 29, 1:304
August 30, 1:335
August 31, 1:346

B. Data should be compared to prisoners received and other categories. Trends that the students may notice will vary

Analyzing the Data:

Understanding Suffering at Andersonville
Teacher's Guide & Answer Key (p.1)

1. What was the distance between the southwest corner and northeast corner of the prison?

a. The Pythagorean Theorem (a2 + b2 = c2) is used to solve this problem.
b. The dimension of the stockade "rectangle" is 1,620 ft. x 779 ft. (a = length and b = width).
c. 1,6202 + 7792 = c2
d. 2,624,400 + 606,841 = c2
e. 3,231,241 = c2
f. c2 = 3,231,241
g. c = √3,231,241
h. c = 1797.57
i. The distance between the two corners of the stockade was approximately 1798 feet.

2. If the total population of the prison increased by 10% on September 1st, what would the new population be? If on September 1st there was a prisoner uprising and the guards opened fire with rifles and cannons killing 25% of the prisoners and severely injuring 10% of those who were not immediately killed, then what would the new population be and how many prisoners would need medical attention? (Students will need to use the data from the daily returns, August 1864)

a. The total population of the prison on August 31st needs to be multiplied by 10%., giving 34,862 prisoners on September 1st.
b. 25% of the population needs to be subtracted from the number found in step "a." This will give the new population total. So 34,862 (prisoners September 1st) x 0.25 (the percent that was killed) = 8,716 (total prisoners that were killed). 34,862 (prisoners September 1st) - 8,716 (prisoners that were killed) = 26,146 (the new prison population).
c. 10% of the population needs to be subtracted from the number found in step "b." This will give you the number of prisoners that need medical attention. 26,146 (the new/remaining prison population) x 0.10 (the percent that were severely injured) = 2,615 prisoners severely injured and need medical attention.

Analyzing the Data:

Understanding Suffering at Andersonville Teacher's Guide & Answer Key (p.2)

3. Assuming that each prisoner would have needed 48 square feet (the standard size of modern jail cells) to survive the month of August, what would the new dimensions of the prison need to be? Express your answer in square feet and acres. Use the number of prisoners on hand on August 1st found in the Consolidated Monthly Return to solve this problem. 1 acre = 43,560 square feet

a. The total population of the prison on August 1st needs to be multiplied by 48 square feet. 31,678 (prisoners on hand August 1st) x 48 sq. ft. per prisoner = 1,520,544 sq. ft. needed.

b. The available space INSIDE the deadline must be determined. The prison dimensions (taking into consideration that the prisoners could not occupy the space within the "dead line") were 1,582 ft. (length) x 741 ft. (width) = 1,172,262 sq. ft. (space available inside the "dead line").

c. The amount of additional space needed must be determined using the totals in step "a" and step "b." 1,520,544 sq. ft. (total needed) - 1,172,262 sq. ft. (current space available) = 348,282 sq. ft. (additional space needed).

d. The value found in step "c" should be divided by the current width of the stockade inside the deadline. This will give the length that must be added. 348,282 sq. ft. (space needed) ÷ 741 ft. (the current width of the stockade rectangle inside the "dead line") = ~470 ft. (needed to be added to the LENGTH of the stockade rectangle).

e. The current length of the stockade should be added to the value found in step "d." This will give the total length of the prison that would be needed. 1,620 ft. (the current length of the stockade including "dead line" at both ends) + 470 ft. (length needed to be added) = 2,090 ft. (total length of the new, larger stockade). The new dimension of the prison stockade would be 2,090 ft. (length) by 779 ft. (width).

f. The new length multiplied by the old (or same) width will give the new total square footage. 7. 2,090 ft. - 38 ft. (for both "dead line" spaces) x 779 ft. - 38 ft. ("dead line") = 1,520,532 sq. ft. of the 1,520,544 sq. ft. calculated as being needed.

g. The acre to square feet ratio needs to be used to determine acreage. There are 43,560 sq. ft. in an acre. 1,520,544 sq. ft. (amount of space needed) ÷ 43,560 (sq. ft. per acre) = 34.91 total acres occupied by the new stockade, with 8.41 of those acres added to the original 26.5 acres.

Analyzing the Data:

Understanding Suffering at Andersonville
Teacher's Guide & Answer Key (p.3)

4. If a particular virus infected the prison population and had a 100% mortality rate, then how many days would it take for 50% of the total population to die? Use the population of the prison as of August 31st and assume that no more prisoners are added to the population because of the virus outbreak. Also, assume that once a prisoner is contagious he has 24 hours to live and will infect exactly two more prisoners before death.

a. Divide the total number of prisoners on August 31st by two. This number represents 50% of the prison population. 1. 31,693 (prisoners on hand August 31st) x 0.50 = 15,847 (half the prison population as of August 31st).

b. Multiply 1 by 2. These numbers represent the host (the first person to be infected by the virus), and the two individuals that the host spreads the virus to. Keep multiplying by two (since each carrier infects exactly two more people before death) until you reach a number that is equal to, or more than, the number found in step "a." 1 (the original virus host) x 2 (prisoners infected by host) = 2 (total infected after host dies). 2 (total infected at this point) x 2 (the number the infected will each infect) = 4 (total infected after the original two die). 4 (total infected at this point) x 2 (the number the infected will each infect) = 8 (total infected after the original 4 die). Continue to multiply by two (the number that each infected person will infect) until AT LEAST 15,847 (half the prison population) is reached.

c. Count the number of times you multiplied by two. Each time this is done represents one day. After multiplying by two 14 times you will reach 16,384. This is at least half the prison population.

d. Add 1 to the number found in step "c." This represents the host and the 24 hour period that he was infected. 1 (the prisoner/host who lived for 24 hours) + 14 (the number of times multiplied by two) = 15 days it would have taken for the virus to wipe out at least half the prison population.