

**Explore & Explain: Graphing Population Growth**

A census is a population survey, which records the number and type of individuals.

Dr. Hyrenbach has been censusing the FSP Wedge-tailed Shearwater population since 2009. The tables below show the number of active nests from 2009-2019 during the incubation period (July 14) and the chick-provisioning period (September 14). Active nests consist of incubating adults (with an egg) and chicks (with or without a parent). Remember: a pair of shearwaters in one nest only lay one egg, and can only produce one chick per year. Follow the directions to learn more about the shearwater breeding season and about how their numbers have changed over time at the preserve.

1. **Incubation survey**: Performed yearly, on July 14.

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Active Nests (Total)** | **Incubating Adults****(your symbol: \_\_\_\_\_)** | **Chicks Alone****(your symbol: \_\_\_\_)** |
| 2009 | 106 | 106 | 0 |
| 2010 | 78 | 78 | 0 |
| 2011 | 138 | 138 | 0 |
| 2012 | 182 | 182 | 0 |
| 2013 | 201 | 201 | 0 |
| 2014 | 216 | 216 | 0 |
| 2015 | 268 | 268 | 0 |
| 2016 | 226 | 226 | 0 |
| 2017 | 273 | 273 | 0 |
| 2018 | 309 | 309 | 0 |
| 2019 | 318 | 318 | 0 |
| **TOTAL** | **2315** | **2315** | **0** |

1. **Chick-provisioning survey**: Performed yearly, on September 14.

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Active Nests (Total)** | **Incubating Adults****(your symbol: \_\_\_\_)** | **Chicks Alone****(your symbol: \_\_\_\_)** |
| 2009 | 71 | 0 | 71 |
| 2010 | 61 | 0 | 61 |
| 2011 | 66 | 0 | 66 |
| 2012 | 137 | 0 | 137 |
| 2013 | 175 | 0 | 175 |
| 2014 | 126 | 0 | 126 |
| 2015 | 84 | 0 | 84 |
| 2016 | 91 | 0 | 91 |
| 2017 | 145 | 0 | 145 |
| 2018 | 217 | 0 | 217 |
| 2019 | 218 | 0 | 218 |
| **TOTAL** | **1391** | **0** | **1391** |

**Directions for Graphing**

* Write the title of each of your graphs on top of the image.
* The X-axis represents the time (years) when the counts were collected. Label the X axis accordingly and add a tick mark for each year, leaving some space between consecutive years. To take less room, feel free to use “9” for “2009”, “10” for “2010”, and so on. Before you draw the tick marks, choose an interval that will allow you to label 11 years (from 9 to 19) and leave a few (2 to 4) squares in between consecutive tick marks, so you can draw a line between the consecutive yearly values.
* The Y-axis represents the number of active nests, incubating adults, and chicks counted in a given year. Before you draw the tick marks, choose an interval that will allow you to label your Y-axis from 0 – 320 (since the maximum value is 318). I suggest making each square of the paper count as 10 birds, so you will need the Y-axis to be 32 squares tall.
* Use a different color pencil to mark each type of data (active nests, incubating adults, chicks).
* Use a different symbol to indicate the data you are plotting and record it in the data tables provided. For example, my symbol for Incubating Adults is 🗆 (red square) and for Chicks is ★(green star).
* Make two separate line graphs (one for the July count data and another one for the September count data) by connecting the points of the same type of data over time (from 2009 to 2019).
* Use your graphs to help you answer the following questions.

**Directions for Calculating Nesting Success**

To quantify how well shearwater reproduction has gone in different years, researchers compare the number of active nests in July (the incubation period) and in September (the chick-rearing period) of the same year. Because the number of active nests in July varies from year to year, this comparison involves calculating the percentage of the nests initially documented in the first count (July) that remained in the second count (September). Note that the number of active nests in July is always larger than in September, because some nests fail: some egg do not hatch into a chick, and some chicks die before they are counted. So, we set up the number of active nests in July as the total (100%) for that year. Then, we calculate the proportion that remain in September. For example, if there were 200 active nests in July and only 50 active nests in September, 25% (50 / 200) of nests were successful and 75% (175 / 200) of nests failed. Note, these proportions add to 100%.

Calculate the nest success rate for each year (2009 - 2019) using a calculator and the provided data sheet. Then, summarize the nest success data across all years, using four variables: the mean (the average of the data), the median (the mid-point of the data), the minimum, and the maximum.

Biologists often use the mean to describe what we would expect to happen, “on an average year”, and the minimum and the maximum to describe the possible range of values we could expect.

We use the median (the mid-point of the data) to classify the values into two groups of equal size:

1. the upper half, with the values larger than the median
2. the lower half, with the values smaller than the median

In this lesson, we will use the median as a baseline, and classify each year as a “good” or “bad” year

(Good = survivorship value above the median, Bad = survivorship value below the median).

Show your work, in the spaces provided in the table below.

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| **Year ------- Active Nests**  | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **Average** | **Median** |
| September Count | 71 | 61 | 66 | 137 | 175 | 126 | 84 | 91 | 145 | 217 | 218 |  |  |
| July Count | 106 | 78 | 138 | 182 | 201 | 216 | 268 | 226 | 273 | 309 | 318 |  |  |
| Nesting Success (%) |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Good or Bad Year? |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Discussion Questions**

1. Describe how the patterns differ, in terms of the number (and proportion) of active nests with incubating adults and with chicks, between July and September.

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1. Describe the patterns in the total number of active nests in July between 2009 and 2019.

(Hint: What year has the maximum number and what year has the minimum?)

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1. Describe the patterns in the total number of active nests in September between 2009 and 2019.

(Hint: What year has the maximum number and what year has the minimum?)

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1. How do the years with the maximum and minimum counts in July and September compare?

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1. Can you think of two reasons why a chick count in September could be low?

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1. Describe the overall trend in the population, using the number of incubating adults (in July).

Hint: You can do this in two ways:

1. Does the number increase every year? Calculate the proportion of years when the number increases and use that probability to predict a population increase in the future.

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1. Calculate the average number of active nests added every year, to estimate how many active nests we would expect to have in the future. Calculate the minimum and the maximum number of active nests added every year, to consider the possible population changes from year to year.

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