

## EVOLUTION ASSESSMENT SCORING RUBRIC

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## Galápagos Ground Finches

(Total possible points = 9)

### Question 1.

What patterns do you observe in Beak Length from 1973 to 1978?

POSSIBLE POINTS = 1

| Points | Required Components of Answer                                                                           | Examples                                                                                                                                                                                                              |
|--------|---------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| +1     | Accurately cites at least one pattern across the 2 graphs. Student does not have to cite specific data. | <i>There are more birds with short beaks in 1973 compared to 1978.</i><br><br><i>In 1973, there were no birds with beak lengths greater than 12mm, but there were some birds with beak lengths that long in 1978.</i> |

### Question 2.

What patterns do you observe in Wing Length from 1973 to 1978?

POSSIBLE POINTS = 1

| Points | Required Components of Answer                                                                  | Examples                                                                                                       |
|--------|------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| +1     | Accurately cites one pattern across the 2 graphs. Student does not have to cite specific data. | <i>In both years, there are a group of birds with small wing lengths and a group with larger wing lengths.</i> |

### Question 3.

In the bottom pair of graphs about wing lengths, what is true about the total number of finches with shorter (35 - 45mm) and longer (60 - 75mm) wings over time?

POSSIBLE POINTS = 1

- A. Both shorter- and longer-winged finches decreased in number.**  
B. Longer-winged finches decreased in number.  
C. Shorter-winged finches decreased in number.  
D. The number of both kinds of finches stayed about the same.

### Question 4.

Now look at all the graphs. Which trait, beak length or wing length, has changed the most in the population over time? Support your answer by describing the change in proportion of the trait over time.

POSSIBLE POINTS = 2

| Points | Required Components of Answer | Examples |
|--------|-------------------------------|----------|
|--------|-------------------------------|----------|

|    |                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| +1 | <p>Accurately compares beak lengths in 1973 &amp; 1978. OR Accurately compares wing lengths in 1973 &amp; 1978.</p> <p>Student has to provide specific data from one set of graphs.</p>          | <p><i>In the 1973 graph, the max beak length was 12.9 mm and the minimum was 7 mm. However, in the 1978 graph, it shows that the max beak length is 13.9 mm while the minimum beak length is 8.5 mm.</i></p>                                                                                                                                                                                                                                                          |
| +1 | <p>Correctly describes relationship patterns in terms of proportions (long beaks to short beaks or vice versa).</p> <p>Student has to use specific numbers and calculate proportions/ratios.</p> | <p><i>In 1973 about 1 in 6 (6/35) birds have beaks 11mm or longer, but in 1978, half of the birds (8/8) have beaks 11mm or longer.</i></p> <p>INCORRECT RESPONSES</p> <p><i>The graph distributing the beak length. This is because it shows as the years go on the beaks got longer</i></p> <p><i>The graph that shows wing length showed more population change over time. Beak length stays pretty much the same and wing length had some drastic changes.</i></p> |

#### Question 5.

One of the changes that happened during the study period was that there was less food available for the finches. Using evidence from the study and your understanding of how traits change in finch populations over many generations, develop an explanation for how having less food may have caused beak length to change in the population between 1973 and 1978.

POSSIBLE POINTS = 3

| Points | Required Components of Answer                                                                                | Examples                                                                                                                                                                                                                    |
|--------|--------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| +1     | Mentions that birds with longer beaks may be passing that trait to their offspring                           |                                                                                                                                                                                                                             |
| +1     | Mentions that longer beaks provide a competitive advantage for food/resources/eating                         | <p><i>The beaks got longer because they had to get new sources of food which was deeper in the soil.</i></p> <p><i>The finches who were designed for or more able to access food due to their beak length survived.</i></p> |
| +1     | Shift in population - Says/implies more birds have longer beak lengths over time (beak length is increasing) | <p><i>The number of finches with beak lengths under 11 mm drastically dropped, while the number of finches with a longer beak length generally stayed the same.</i></p>                                                     |

Question 6.

What do you predict will be the proportion of birds with beaks that are 11mm or longer in another five years, if the environmental conditions stayed the same? Use mathematics to support your answer by first calculating the rate at which the proportions are changing.

POSSIBLE POINTS = 2

| Points | Required Components of Answer                                                                                                                                                                                                                                                                                            | Examples                                                                                                                                                                                                                                                                                                                                                |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| +1     | <p>Appropriately calculates the rate the proportions are changing to support their answer in terms of number or percentage of birds with long beaks over time (does not need to include number of birds with short beaks)</p> <p>They have to show their calculations, using ratios or proportions (e.g. 1:2, 6/41).</p> | <p>1973: <math>6/41 = 15\%</math><br/>1978: <math>8/16 = 50\%</math><br/>35% increase<br/>If the environment stays the same, the proportion of the population will be 85%.</p> <p>I believe 75% of the birds in 5 years will have beaks longer than 11 mm. Going from 1973 to 1978 the proportion of long-beaked birds went from around 1:4 to 1:2.</p> |
| +1     | <p>Uses some math correctly to support their answer (e.g. refers to data in the table)</p>                                                                                                                                                                                                                               | <p>Between 1973 and 1978 the number of finches whose beaks were over 11 mm increases by 2. If the environment stays the same, there should be another increase in population</p>                                                                                                                                                                        |

## Evolution of Swallows

(Total possible points = 10)

### Question 1.

What do you think are some of the challenges for cliff swallows living in this new environment that did not exist before the highway was built?

QUESTION 1 POSSIBLE POINTS = 1

| Points | Required Components of Answer                                                                   | Examples                                                                                                                                                                                                                                                     |
|--------|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| +1     | Cites at least 1 risk/challenge associated with living in the environment that affects survival | <i>There is a lot of risk of getting hit by a car driving underneath the freeway. The exhaust might also poison their lungs.</i><br><br><i>Disadvantage would be constant competition for food and mates since the competition would all be in one space</i> |

### Question 2 (Short Answer).

Do you think birds with longer wings or shorter wings are more likely to have an advantage that allows them to survive better in this new environment? Explain your answer.

QUESTION 2 POSSIBLE POINTS = 3

| Points | Required Components of Answer                                                  | Examples                                                                                                                                              |
|--------|--------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| +1     | Correct trait: Shorter wings                                                   | <i>Shorter wings are more advantageous for survival</i><br><br><i>Birds with shorter wings are more likely to survive.</i>                            |
| +1     | Shorter wings allow the birds to maneuver quickly to avoid cars on the highway | <i>With shorter wings, birds can more easily avoid cars</i>                                                                                           |
| + 1    | States why (compared to what) shorter wings are advantageous in the population | <i>This is an advantage over birds with longer wings who cannot change directions as quickly and are therefore more likely to get killed by a car</i> |

### Question 2 (Alternate - Multiple-Choice).

Birds with which wing length are more likely to have an advantage that allows them to survive better in this new environment? (Circle One)

- A. Shorter wings, because they allow swallows to take off quickly after getting food.
- B. Shorter wings, because there is more drag on their wings.
- C. Longer wings, because they require less energy for flight.

D. Longer wings, because they can fly farther with them.

Question 3:

Complete the table below using the pattern of data in the graph to explain what is happening in the cliff swallow population from 1984 to 2012. *Note: Wing length is a heritable trait.*

QUESTION 3.2 POSSIBLE POINTS = 2

| Points | Required Components of Answer                                     | Examples                                                                                                                                                           |
|--------|-------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| +1     | Describes at least one advantage of shorter wings                 | <i>The shorter wings help the birds be able to fly faster</i>                                                                                                      |
| +1     | Provides a piece of evidence about wing length based on the graph | <i>The data show that most of the roadkill victims have larger wings.</i><br><br><i>There are more birds in the population with shorter wing length over time.</i> |

QUESTION 3.3 POSSIBLE POINTS = 2

| Points | Required Components of Answer                                                                                        | Examples                                                                                                                                            |
|--------|----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| +1     | Mentions the population of swallows becoming adapted to its new environment, as evidenced by increased nesting sites | <i>There are more swallows surviving, because there are more with shorter wings</i>                                                                 |
| +1     | Mentions the population of swallows becoming adapted to its new environment, as evidenced by decreased road kills    | <i>There are more swallows surviving, because the long-winged swallows were all killed off early on, and those that remain were better adapted.</i> |

QUESTION 3.4 POSSIBLE POINTS = 1

| Points | Required Components of Answer                                                                           | Examples                                                                                                                                                                                                   |
|--------|---------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| +1     | Mentions a specific pressure of the environment (e.g., cars, predators) and relates that to wing length | <i>Smaller wings may allow the bird to fly faster, especially when flying away from an incoming car</i><br><br><i>Birds with shorter wings can make more evasive maneuvers to escape oncoming traffic.</i> |

QUESTION 3.5 POSSIBLE POINTS = 3

| Points | Required Components of Answer                                                            | Examples |
|--------|------------------------------------------------------------------------------------------|----------|
| +1     | Refers to survival of swallows with shorter-wings and/or death of those with longer wing |          |

|    |                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                          |
|----|-------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| +1 | Refers to reproduction or passing on advantageous traits                                                                            | <p><i>The threat of the cars causes natural selection by killing off long-winged birds &amp; leaving the short-winged birds to reproduce</i></p> <p><i>The pressure from the highway environment has allowed swallows with shorter wings to live more and reproduce, passing on their hereditary trait through natural selection</i></p> |
| +1 | <p>Correctly discusses adaptation</p> <p>(If the student discusses adaptation in any of the above responses, give a point here)</p> | <p><i>The swallow population is somehow adapting to the different conditions of the nests underneath the highways.</i></p> <p><i>The swallows are adapting to their new environmental home. Over time, the swallows learn of the dangers of the highway and adapt accordingly to avoid those dangers.</i></p>                            |

#### Question 4.

Draw a dot on the chart below to indicate what you predict the average wing length will be in 2020. How did you estimate where to place the dot? What do you assume in the environment was changing or staying the same in the future?

#### QUESTION 4 POSSIBLE POINTS = 3

| Points | Required Components of Answer                                                                                                                                       | Examples                                                                                                                                                             |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| +1     | Explain that estimate uses the line of best fit. Student does not have to use the actual term "best fit", but must describe the action of following line or pattern | <p><i>I followed the line of best fit from the previous data to determine how many short-winged birds there would be</i></p> <p>Extending the line to 106 counts</p> |
| +1     | Estimate is roughly 106<br>(Roughly = within 1 point of 106)                                                                                                        |                                                                                                                                                                      |
| +1     | Assumption that the environment didn't change, selection pressures remain the same                                                                                  | <p><i>I assumed shorter wings remained an advantageous trait.</i></p> <p><i>I assumed that cars would still be a danger to the swallows.</i></p>                     |

## Two Species or One?

(Total possible points = 10)

### Question 1.

On the basis of these data, which group of robins most likely shares a most recent common ancestor with the Norfolk Island robins?

NO POINTS

### Question 2.

Which data best support your claims? Why are these data important to scientists in determining common ancestry?

POSSIBLE POINTS = 2

| Points | Required Components of Answer                       | Examples                                                                                                                                                                                     |
|--------|-----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| +1     | Accurately describe genetic, wing length similarity | They have the most similar DNA, they look the most alike<br><br>A species that shares similar genetic makeup most likely shared identical DNA at one point, they have just slightly evolved. |
| +1     | Relate the data to common ancestry                  | This is important to scientists because common DNA means they could be from a similar species or ancestor.                                                                                   |

### Question 3.

What patterns in the data are relevant to deciding whether the species are the same or different, but do **not** support your claims? Why are these sources of data in general important to scientists in determining common ancestry?

POSSIBLE POINTS = 2

| Points | Required Components of Answer                                                                   | Examples                                                                                                                                                                                                                                                                               |
|--------|-------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| +1     | Addresses why the data are important to determine common ancestry or relatedness of the species | <i>This is important because the closer related the robin species are the more likely it is for the robins to have the same wing length.</i><br><br><i>They are important data to scientists because of the DNA traits and genetics that are shared among ancestors and offspring.</i> |

|    |                                                                                                                                                                            |                                                                                                                                                                                                                                                                                           |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| +1 | <p>Correctly describes a different pattern in the data that is relevant (wing length or DNA).</p> <p>They don't need to say that the data DOESN'T support their claim.</p> | <p><i>Wing length is important but does not support my claim since it would not show the Red Capped Robins being a recent ancestor.</i></p> <p><i>The wing length data of each of the robins is very different which leads you to believe that each robin is a different species.</i></p> |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

#### Question 4.

If you were a scientist, what would you conclude: Should the Norfolk Island robins be considered a unique species? What evidence supports your conclusion? What is your reasoning: in other words, why is that good evidence to support your conclusion?

POSSIBLE POINTS = 2

| Points | Required Components of Answer                                                                                                                                                                                                                     | Examples                                                                                                                                                                                                                                                                               |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| +1     | <p>Student states yes or no (it's a unique species) and correctly uses evidence from the given information.</p> <p>Must discuss at least one piece of information about a specific trait from the given data in connection to their argument.</p> | <p><i>No, because there is the Scarlet Robin that is similar to the Norfolk Robin in wingspan. So it isn't too unique if another species is just like it.</i></p>                                                                                                                      |
| +1     | <p>Student uses reasoning around similarities/differences in DNA/wing length to connect their evidence to their conclusion - by talking about ancestry, reproduction, and/or adaptation</p>                                                       | <p><i>Yes, they should be considered their own species because they have adapted and changed too much from their ancestors to be able to say they are like any other nearby robin species. The extreme differences in wing length prove that they should be their own species.</i></p> |

#### Question 5.

What is one additional piece of evidence that would help convince you that the Norfolk Island robins are the same or different from other island bird species? Say what the evidence would have to show to support your claim.

POSSIBLE POINTS = 2

| Points | Required Components of Answer                                                                                                                                                                                                                                                                                                            | Examples                                                                                                                                             |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| +1     | <p>Student provides <u>one</u> appropriate piece of evidence from the list below:</p> <ul style="list-style-type: none"> <li>• Gene flow between the two populations (eg. ability to mate &amp; produce fertile offspring)</li> <li>• Additional evidence about similarities and differences in the birds' heritable physical</li> </ul> | <p><i>The types of beaks the robins have based on their diet would prove they are different species, as long as the beaks are all different.</i></p> |

|    |                                                                                                                                                                                                                                           |                                                                                                                                                                            |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | <p>characteristics that perform the same function, not from the given data (e.g., flying, beak length)</p> <ul style="list-style-type: none"> <li>• Data on embryological development (e.g., similarities in developing bones)</li> </ul> |                                                                                                                                                                            |
| +1 | <p>Student uses reasoning to create a logical argument that connects the evidence to their conclusion (Associated with the appropriate bullet above). A logical argument means stating why the evidence would support their claim.</p>    | <p><i>I would want to see some of the birds eating habits, what do they like to eat? You could study the two and see how their behaviors are similar or different.</i></p> |

#### Question 6.

The Pacific Robin and Red-Capped Robin do not interbreed, because they cannot reach each other in flight (their short wings are not useful for flying long distances). Additionally, over time their habitats may start to vary: The Pacific Robin's habitat will likely be the same because people decided to protect the environment and limit any future development. The Red-Capped Robin's habitat is at risk of being destroyed by human activity (such as through building hotels for tourists). Over multiple generations, what could happen to these two populations? (Circle two plausible answers):

- A. The two populations' wing lengths would stay about as similar to one another as they are today.
- B. The two populations' wing lengths would become more different from one another as the Red-Capped robins adapted to different conditions.
- C. The Red-Capped Robin population would go extinct.

Explain your reasoning for each answer you select.

POSSIBLE POINTS = 2

| Points | Required Components of Answer                                   | Examples                                                                                                                                                  |
|--------|-----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| +1     | Provides accurate reasoning about the first circled answer      | <i>I have chosen B because over time wing size may have changed and the bigger birds can fly farther and reach destinations to get food and survive.</i>  |
| +1     | Provides accurate reasoning about the second the circled answer | <i>Answer C is plausible because if the birds' environment changes too quickly, the species will not have time to adapt, and they eventually die out.</i> |

Accurate reasoning for A: Must state that wing length doesn't matter for survival in either environment or wing length isn't adapting in either population.

Accurate reasoning for B: Must state an advantage of wing length adaptation. Eg. With longer wing length, the robins will be able to travel further for food.

Accurate reasoning for C: Must talk about adaptation/unable to adapt/will die out if they don't adapt



## Human Adaptation on the Tibetan Plateau

(Total possible points = 10)

### Question 1.

Using the information in the table about *people visiting the mountains* and *Tibetans living at high elevations*, construct an explanation for why, over many generations, the people of Tibet today are physiologically different from people living at lower elevations.

POSSIBLE POINTS = 4

| Points | Required Components of Answer                                                                                                                                           | Examples                                                                                             |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| +1     | Says that the difference between highlanders and lowlanders is caused by natural selection/adaptation (must accurately use one of these vocab words)                    | <i>Their ancestors' bodies adapted to the high elevation and passed that down to their children.</i> |
| +1     | Accurately describes a trait in the population                                                                                                                          | <i>The heart rate and blood vessels are different from lowlanders.</i>                               |
| +1     | Connects a specific advantageous trait to a better chance of survival at high altitudes or says those with specific less advantageous traits might not survive as well. | <i>Their bodies have created a way to live and survive without having altitude sickness.</i>         |
| +1     | Connects surviving to reproducing                                                                                                                                       |                                                                                                      |

### Question 2.

If conditions in Tibet remain stable for the next 1000 years...

- predict how will the proportion of individuals with big blood vessels living in the area will change (increase, decrease) and
- justify your predictions using evidence from the text.

POSSIBLE POINTS = 2

| Points | Required Components of Answer                                                                                                | Examples                                                                                                                        |
|--------|------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| +1/2   | Big blood vessels will increase                                                                                              |                                                                                                                                 |
| +1/2   | Small blood vessels will decrease                                                                                            |                                                                                                                                 |
| +1/2   | Reasoning around big blood vessels includes linking survival to reproduction (inheriting a trait) and/or natural selection   | <i>The children will get the trait from their parents</i><br><i>There are more people being born with larger blood vessels.</i> |
| +1/2   | Reasoning around small blood vessels includes linking survival to reproduction (inheriting a trait) and/or natural selection | <i>This trait is not favorable to high altitudes and therefore natural selection will lower the population</i>                  |



### Question 3.

Recent scientific studies have documented variation in the alleles of Tibetan women. The alleles being studied are indicated as A and B below and represent alternative versions of a trait that affects oxygen content in the blood of the women. High oxygen content is important for survival at high altitudes. Describe two pieces of evidence in the table below that support the claim that allele B is affected by selection pressure.

POSSIBLE POINTS = 2

| Points | Required Components of Answer                                           | Examples                                                                                                                                                                                                                     |
|--------|-------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| +1     | Provides 1 piece of evidence directly from table or compare proportions | <i>Mothers with the BB genotype had a drastic decrease when it comes to the proportion of live births that died during infancy and before 15 years of age.</i><br><br><i>They had a lower chance of survival after birth</i> |
| +1     | Provides 1 additional piece of evidence directly from table             | <i>They also had fewer infant deaths.</i>                                                                                                                                                                                    |

### Question 4.

What do you predict will happen to the relative frequency of Allele B in the population of Tibetan women over many generations? Explain why and cite data from the table above as evidence.

POSSIBLE POINTS = 2

| Points | Required Components of Answer                                                                                                                                   | Examples                                                                  |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| +1     | Says people with Allele B will survive and/or reproduce OR those without Allele B will be less likely to survive (more likely to die)                           | <i>If future generations don't have a B allele they will not survive.</i> |
| +1     | Cites data from the table as evidence. They must talk about one of the 4 variables (e.g., low number of infant deaths, only 6% of children died during infancy) |                                                                           |