**ACTIVITY: Exploring genetic variation**

**Activity idea**

In this activity, students gain an understanding of the importance of genetic diversity within a population.

By the end of this activity, students should be able to:

* identify possible outcomes of a lack of genetic diversity within a population of translocated bird species
* identify requirements for genetic diversity within bird populations
* discuss why scientists need to consider genetic diversity when preparing for a translocation of a threatened population.

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**Introduction/background**

Scientists know that some native bird populations are at risk due to the effects of habitat loss and predation. An important factor that scientists need to consider when conserving populations of our native bird species is genetic variation.

***Translocation***

Translocation has emerged as an important technique in threatened species recovery. Scientists identify a target population, ensure they are of optimum health and free of disease and then locate a new environment for the individuals. The translocation site identified must be large enough and offer a variety of naturally occurring food sources to sustain the population and allow it to grow. The environment must also be predator-free. Intensive work is done to eradicate pest populations before any new species is introduced to the area.

Offshore islands make popular choices for translocation sites as they have a natural barrier – water – separating them from the mainland. Mainland sites surrounded by predator-proof fences are also used as translocation sites. When scientists arrange a translocation of a threatened species to an offshore island, they must also consider maintaining adequate genetic diversity within the species. A good example of this is the Chatham Island black robin.

***Old Blue***

Conservation biologists made history by bringing the population of Chatham Island black robins back from the brink of extinction. In 1976, the population of black robins stood at 5 individuals, only 1 of which was a female capable of breeding. She was named ‘Old Blue’ because of the blue band on her leg. The male she paired with was named ‘Old Yellow’. Scientists spent 30 years helping to restore the population of black robins starting with these 2 birds. Currently, there are around 250 black robins, which are located in 2 separate populations on Rangatira and Māngere Islands.

***Genetic variation***

With reduced numbers, threatened species have a limited gene pool to provide diversity within their population. A lack of genetic diversity can result in populations having limited resilience against environmental pressures. Scientists know that there is increased susceptibility to disease when there is reduced genetic diversity within a population.

Hatching success is also limited in populations with reduced genetic diversity. This has been noted within the black robin population, which has high rates of nesting failure.

When preparing for a translocation, scientists must consider several factors, including:

* the fitness of the individuals
* the suitability of the new habitat
* whether the population will have enough genetic diversity to allow it to adapt over several generations to a changing environment.

**What you need**

* A copy of *Old Blue: The Rarest Bird in the World* by Mary Taylor (Ashton Scholastic, 1993)
* Map of New Zealand
* Photographs of families (brought in by the students/or cut out of magazines)
* 16 x eyedroppers
* 8 x different coloured dyes made up to 100mL in jars
* Small see-through plastic cups (enough for 2 per student)
* Newspaper
* Popsicle sticks (optional)

**What to do**

***Introduction***

1. Share with the students the picture book *Old Blue: The Rarest Bird in the World* by Mary Taylor.
2. Ask students to locate the Chatham Islands on a map of New Zealand.
3. Discuss with the students the science ideas of translocation and conservation.
4. Ask students to offer ideas that the Department of Conservation rangers would have needed to consider before translocating the black robins.
5. Ask the students: “What problems might occur by having a population of only 5 birds to begin with?”

***Identifying diversity***

1. Ask students to bring in a photograph of their family (or use pictures of families cut out of magazines).
2. In small groups, discuss the features of the families that are similar (for example, eye and hair colour or skin tone).
3. Now ask the groups of students to concentrate on the individuals in the classroom. What generalisations can they make about eye and hair colour, skin tone and other features of the members of the class. Ask the students: “Why do we have so much variation within our classroom?” You could further extend the students by asking them to share the good things about having increased diversity in the classroom.
4. Explain that diversity is due to there being many different parents within the classroom. Our parents pass on genes to us that are similar to the ones they have. This is why we may look similar to members of our families. We also inherit traits from our parents that we cannot see – this might include our immune system (our ability to fight off infection) or functions of our body that affect ability in activities such as sport. This is the same with birds and other living things.

***Mixing dyes***

1. Explain that this activity will give a visual representation of how genetic diversity within a population depends on the size of the initial population (i.e. how many parents there are).
2. Set up 4 stations around the classroom, each with a different coloured dye (for example, red, blue, yellow and green) and 2 eyedroppers. You will need approximately 100mL of dye in each jar. It is a good idea to put down newspaper to prevent spills.
3. Model to the students how to use the eyedropper to extract dye from the jar and add 10 drops to a small clear plastic cup. Then repeat with a different colour. Swirl the cup gently to mix the two colours. Alternatively, students could be given a popsicle stick to stir their sample with and then throw this away after use.
4. Give each student 1 plastic cup and the following instructions for the activity. They will need to add 10 drops of their first chosen colour to their cup, leaving the eyedropper behind at the dye station to prevent contamination, and then add 10 drops of a different colour (not the same dye as the first one chosen). The cup will then need to be placed on a central table. It is very important that the students understand that they can only add 10 drops of each colour to prevent variation in the depth or intensity of the new colour formed.
5. Line up the cups of dye on a central table where all students can see. If 2 cups have the same colour ‘offspring’, then place one behind the other. Discuss how many new ‘offspring’ have been produced from 4 parents.
6. Give each student another cup and explain that the class will repeat the process with 8 different coloured dyes. Ask students to make a prediction of how many new samples they think will be created and why they think so.
7. Carry out the experiment with 8 dyes. To make this process more manageable, it would be a good idea to split the students in the class between the 8 different dye stations so that there is coverage of all different dyes within the class.
8. Compare the results of the first experiment with 4 initial dye samples (parents) to the results with 8 dye samples. The total number of plastic cups will be the same, so students should draw conclusions that there is much greater diversity produced when there is a larger initial population size.

**Discussion questions**

* What considerations must scientists make before they undertake a translocation?
* If there is a lack of genetic diversity within a population, what might result?
* How can scientists ensure that there is enough genetic variation within a population?

**Extension ideas**

* Variations in the numbers of dye samples used can be made.
* Using the samples obtained from the experiment with 4 initial dyes, you could simulate an avian flu or environmental impact that badly affects all birds containing genes with blue dye (for example). Show what happens when all of the samples containing blue dye are wiped out (purples, greens and turquoise). What effect has this had on the population now?
* The resulting dye samples from the initial experiment could also be used to repeat the experiment. This would show how diversity can change over generations.