In this activity, you will explore the effects that different novel contaminants can have on frog populations.

**Baseline Instructions:** For each scenario, you will need the appropriate population deck (10 cards) and draw deck (30 cards) provided. The 10 cards that start in the population deck represent the initial population of ten individuals. The draw deck contains the offspring that will be added to the population in each generation. First, shuffle the draw deck and set it aside face down. Then shuffle the starting deck and place it face down.

**1.** Draw cards from the starting population deck two at a time. If a pair contains one black card (male) and one red card (female), this indicates frogs that have successfully found a mate.

**2.** For each successful pair, add cards from the draw deck to the population (representing this pair’s offspring). The exact number of offspring added per pair will depend on the conditions of each scenario. Record the total number of cards as the number of frogs in the population for Generation Two in the data table.

**3.** Reshuffle the population deck and repeat steps 1-2 to get population totals for Generations Three and Four. Depending on the scenario, there may also be additional environmental challenges that affect population size.

**4.** When you have collected data for each scenario, plot the data and discuss the trends you see.

**Scenario #1: 40% Female, No Herbicide**

**Background:** This scenario represents what might be considered a baseline, undisturbed situation. A population where 40% of the individuals are female is considered typical for many species. In this case, the population has not been exposed to herbicide pollution.

**Modifications:** Use the **40% Female** deck. Red cards represent females, black cards represent males. Each successful pair will add **two** offspring to the population.

**Scenario #2: 90% Female, No Herbicide**

**Background:** In this scenario, we include contaminants such as endocrine disruptors – chemicals that can affect the system of hormones in the body. Tadpoles that are exposed to some types of endocrine disruptors may change their sex, resulting in populations that have significantly more females than is typical. In this case, you will investigate an initial population that has been exposed to these chemicals, resulting in a population that is 90% female. There has not been any exposure to herbicides.

**Modifications:** Use the **90% Female** deck. Red cards represent females, black cards represent males. Each successful pair will add **two** offspring to the population.

**Scenario #3: 40% Female, Exposed to Herbicide**

**Background:** In this scenario, there has been no exposure to endocrine disruptors, so the sex ratio of the population is at a typical level. Instead, we consider what happens when some frogs are exposed to herbicide pollution. While many herbicides will not immediately kill frogs that are exposed to them, they can have other effects on population dynamics, such as reducing growth or affecting the immune system, making them more susceptible to disease. Adult size strongly influences reproductive success in many species of frogs.

**Modifications:** Use the **40% Female** deck. Red cards represent females, black cards represent males. In addition, the suit of the card will indicate whether that frog has been exposed to herbicide. Spades and hearts indicate that the frog has **not** been exposed, while clubs and diamonds **have** been exposed.

Exposure to herbicide will influence how many offspring a frog can have. If neither parent has been exposed (**spade and heart**), the pair will still add **two** offspring to the population. If one parent was exposed while the other was not (**spade and diamond** or **club and heart**), the pair will add **one** offspring to the population. If both parents were exposed (**club and diamond**), the pair will add **no** offspring to the population.

In addition, scientists have found that frogs that have been exposed to some types of herbicide have much greater mortality when they are later exposed to chytrid fungus. Chytrid fungus has become a significant problem for amphibians in many parts of the world. In this scenario, after reproduction for Generation Four has occurred, the population will be exposed to chytrid fungus. You will **eliminate all clubs or diamonds** from the population before recording the total in the data table for Generation Four.

**Scenario #4: 90% Female, Exposed to Herbicide**

**Background:** In this scenario, the population has been exposed to both disruptors and herbicide. This will allow you to see how both contaminants together might alter population dynamics.

**Modifications:** Use the **90% Female** deck. Red cards represent females, black cards represent males. In addition, the suit of the card will indicate whether that frog has been exposed to herbicide. Spades and hearts indicate that the frog has **not** been exposed, while clubs and diamonds **have** been exposed.

Exposure to herbicide will influence how many offspring a frog can have. If neither parent has been exposed (**spade and heart**), the pair will still add **two** offspring to the population. If one parent was exposed while the other was not (**spade and diamond** or **club and heart**), the pair will add **one** offspring to the population. If both parents were exposed (**club and diamond**), the pair will add **no** offspring to the population.

In this scenario, after reproduction for Generation Four has occurred, the population will be exposed to chytrid fungus. You will **eliminate all clubs or diamonds** from the population before recording the total in the data table for Generation Four.

**Cheat Sheet for Herbicide Exposure Scenarios**

|  |  |
| --- | --- |
| **Suit** | **Identity of Frog** |
|  | Female  No exposure to herbicide |
|  | Female  Exposed to herbicide |
|  | Male  No exposure to herbicide |
|  | Male  Exposed to herbicide |

|  |  |  |  |
| --- | --- | --- | --- |
| **Reproduction:** | | Female is… | |
|  |  |
| Male is… |  | **2**  offspring | **1**  offspring |
|  | **1**  offspring | **0**  offspring |