**Winners and Losers of Climate Change**

**(adapted with permission from “Drowsy Drosophila: Rapid Evolution in the Face of Climate Change”, Jennifer Broo, Jessica Mahoney, and Julie Bokkor, co-creators,** [**https://www.cpet.ufl.edu/wp-content/uploads/2014/12/Chpt1\_Drosophila2017.pdf**](https://www.cpet.ufl.edu/wp-content/uploads/2014/12/Chpt1_Drosophila2017.pdf)**)**

*Instructions: Use Table 1 below to complete the Species Vulnerability Matrix on the next page.*

**Table 1: Traits associated with species’ heightened sensitivity and lowered adaptive capacity in response to climate change**

|  |
| --- |
| **SENSITIVITY** |
| **a.Specialized habitat and/or microhabitat requirements**  As climate change-driven environmental changes unfold, species that are less tightly coupled to specific conditions and requirements are likely to be more resilient because they will have a wider range of habitat and microhabitat options available to them. Sensitivity is further increased for species with several life stages, each requiring different habitats or microhabitats (e.g., water-dependent larval amphibians) We note, however, that this does not hold in all cases, and extreme specialization may allow some species to escape the full impacts of climate change exposure (e.deep sea fishes). |
| **b.Environmental tolerances or thresholds (at any life stage) that are likely to be exceeded due to climate change**  Species with physiological tolerances that are tightly coupled to specific environmental conditions (e.g., temperature or precipitation regimes, water pH or oxygen levels) are likely to be particularly sensitive to climatic changes (e.g., tropical ectotherms). However, even species with broad environmental tolerances may already be close to thresholds beyond which physiological function quickly breaks down (.e.g, drought tolerant desert plants). |
| **c.Dependence on environmental triggers that are likely to be disrupted by climate change**  Many species rely on environmental triggers or cues to initiate life stages (e.g., migration, breeding, egg laying, seed germination, hibernation and spring emergence). While cues such as day length and lunar cycles will be unaffected by climate change, those driven by climate and season may alter in both their timing and magnitude, leading to asynchrony and uncoupling with environmental factors (e.g., mismatches between advancing spring food availability peaks and hatching dates. Climate change sensitivity is likely to be compounded when different sexes or life stages rely on different cues. |
| **d.Dependence on interspecific interactions that are likely to be disrupted by climate change**  Climate change driven alterations in species’ ranges, phenologies and relative abundances may affect their beneficial inter-specific interactions (e.g., with prey, pollinators, hosts and symbionts) and/or those that may cause declines (e.g., with predators, competitors, pathogens and parasites). Species are likely to be particularly sensitive to climate change if, for example, they are highly dependent on one or few specific resource species and are unlikely to be able to substitute these for other species. |
| **e.Rarity**  The inherent vulnerability of small populations to Allee effects and catastrophic events, as well as their generally reduced capacity to recover quickly following local extinction events, suggest that many rare species will be more sensitive to climate change than common species. Rare species include those with very small population sizes, as well as those that may be locally abundant but are geographically highly restricted. |
| **LOW ADAPTIVE CAPACITY** |
| **f.Poor dispersal ability:**  Intrinsic dispersal limitations: Species with low dispersal rates or low potential for long distance dispersal (e.g., land snails, and raindrop splash-dispersed plants) have lowest adaptive capacity since they are unlikely to be able to keep up with a shifting climate envelope.  Extrinsic dispersal limitations: Even where species are intrinsically capable of long distance or rapid dispersal, movement and/or successful colonisation may be reduced by low permeability or physical barriers along dispersal routes. These include natural barriers (e.g., oceans or rivers for terrestrial species), anthropogenic barriers (e.g., dams for freshwater species) and unsuitable habitats or conditions (e.g., ocean currents and temperature gradients for marine species). Species for which no suitable habitat or ‘climate space is likely to remain (e.g., Arctic ice-dependent species) may also be considered in This trait set. |
| **g.Poor evolvability**  Species’ potential for rapid genetic change will determine whether evolutionary adaptation can result at a rate sufficient to keep up with climate change driven changes to their environments. Species with low genetic diversity, often indicated by recent bottlenecks in population numbers, generally exhibit lower ranges of both phenotypic and genotypic variation. As a result, such species tend to have fewer novel characteristics that could facilitate adaptation to the new climatic conditions. Since direct measures of species’ genetic diversity are few, proxy measures such as those relating to reproductive rates and outputs, and hence the rate at which advantageous novel genotypes could accumulate in populations and species, may be useful. Evidence suggests that evolutionary adaptation is possible in relatively short timeframes (e.g., 5 to 30 years) but for most species with long generation lengths (e.g., large animals and many perennial plants), this is likely to be too slow to have any serious minimising effect on climate change impacts. |

**SPECIES VULNERABILITY MATRIX**: *Check any of the following boxes for each species if the factor is contributing negatively towards the species’ continued success, given the current impact of climate change. Column e, “rarity”, has been completed for you for all 8 species.*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **A.specialized habitat** | **b/c.Environ-**  **mental tolerances/**  **dependence on environmental triggers** | **D.interspecific interaction dependence** | **e.Rarity** | **f.Poor dispersal ability** |  |
| **African Reed Frog** |  |  |  |  |  |  |
| **Asian Tiger Mosquito** |  |  |  |  |  |  |
| **Four Toed Lizard** |  |  |  | x |  |  |
| **Coral** |  |  |  | x |  |  |
| **Fantail Warbler** |  |  |  |  |  |  |
| **Common Coqui** |  |  |  | x |  |  |
| **Poison Frogs** |  |  |  | x |  |  |
| **Hornbill** |  |  |  |  |  |  |

**POST ACTIVITY QUESTIONS:**

1. Calculate the total risk factor for each species by adding the number of checked boxes. Write this number in the blank right-hand column of the matrix. Order the species based on highest to lowest vulnerability below.
2. Any species with 3 or more check marks in the matrix is considered a “loser” in response to climate change. Did any of the species categorized as a “loser” surprise you? What about the “winners”? Why?