EOSC 310 – Assignment 4 Draft

**Part 1:**

Imagine a planet named Daisyworld that is inhabited by two species of daisy as its only life form: black daisies and white daisies. White daisies have bright white flowers that reflect light, while black daisies have darker black flowers that absorb light.

The world is warmed by the incoming solar radiation from the star that it orbits, just like how Earth is warmed by insolation from the Sun. The further away Daisyworld is from the star, the colder is becomes because the surface intercepts less energy which is emitted by the star. Moving the planet closer to increases the planetary surface temperature. This is exactly like what we see in our solar system: planets closer to the Sun tend to be warmer than planets further away.

Like daisies on Earth, the daisies of Daisyworld can only grow if the temperature range they’re exposed to is habitable: not too warm, and not too cold. Because black daisies can absorb more sunlight compared to the white daisies (think about the difference between wearing light vs dark clothing on a hot sunny day), the black daisies are able to survive in cooler temperature than the white daisies. The black daisies absorb more solar energy, warming up the daisies themselves and the soil in which they grow. Conversely, the white daisies can survive in much warmer temperatures than the black ones: if it gets so warm on Daisyworld that the temperatures start to exceed the optimal growing temperature of daisies, the white daisies will do comparatively better than the black daisies. This is because they will reflect more sunlight and therefore absorb less solar energy, keeping them cool. Meanwhile, in these hot temperatures, the black daisies will continue to absorb large amounts of solar energy, exceed the threshold growing temperature, and die back.

Section A: Test the background theory:

1. Which would be warmer: a planet covered in black daisies, or a planet covered in white daisies? (Think about albedo!)
   1. **Black daisies**
   2. White daisies
   3. Not enough information
   4. Trick question, both yield the same end state.
2. For a spherical Daisyworld, where on the globe would we expect to see more black daisies? How about white daisies? (Think about which areas of the planet absorb the most sunlight!)
   1. More white daisies at the poles (like ice caps) and more black daisies at the
   2. More black daisies at the poles and more white daisies at the equator.
   3. Black and white daisies would be evenly distributed globally.
   4. Black daisies in the North and white daisies in the South.
3. If both the albedo of black daisies and the albedo of white daises are higher than the albedo of bare uninhabited ground, then we should expect the local temperature in a field of daisies to be:
   1. A warmer temperature than in an uninhabited zone.
   2. **A cooler temperature than in an uninhabited zone.**
   3. The same temperature as an uninhabited zone.
   4. Either warmer or cooler, depending on the proportion of black and white daisies.

Section B: Interact with the app and explore:

**Tab 1: Constant flux model:**

*The ‘Solar Distance’ slider in the Daisyworld app to increase the planet’s distance from the Sun. This reduces the amount of solar radiation the planet can absorb and lowers the temperature.*

1. Decreasing the amount of solar radiation \_\_\_\_\_\_ the proportion of black daisies and results in a net \_\_\_\_\_\_\_ in the combined albedo of the planet.
   1. Increases, increase.
   2. **Increases, decrease.**
   3. Decreases, increase.
   4. Decreases, decrease.

*Reset all the sliders to their default value by refreshing the page. Use the ‘White daisy albedo’ and ‘Black daisy albedo’ sliders to adjust the albedos of the white and black flowers.*

1. Decrease the white daisy albedo **all the way to 0.5** from the default value of 0.75. What happens to the fractional area of white and/or black daisies? Why? Pick two.
2. **White daisy area increases, black daisy area decreases.**
3. Black daisy area increases, white daisy area decreases.
4. There is no impact on the fractional area of white and black daisies.
5. **Planetary temperature increases, favouring white daisies.**
6. Planetary temperature increases, favouring black daisies.
7. Planetary temperature decreases, favouring white daisies.
8. Planetary temperature decreases, favouring black daisies.

**Tab 2: Varying flux model:**

1. Consider the population of black daisies. Note the sharp jump in the area graph when the first non-zero daisy steady states appear and the corresponding rise in the planetary temperature. What type of feedback on temperature does the appearance of the black daisies result in? Note as well that the graph drops back to zero at a lower value of L than in the case of neutral daisies.
   1. **Positive feedback.**
   2. Negative feedback.
2. Make some observations about the response to changing solar flux. Which species of daisy does better initially? What happens to this species of daisy as solar flux increases?
   1. **Black daisies, population decreases with increasing flux because the planet warms considerably.**
   2. Black daisies, population increases with increasing flux because the planet cools considerably.
   3. White daisies, population increases with increasing flux because the planet cools considerably.
   4. White daisies, population decreases with increasing flux because the planet warms considerably.
3. Set the albedo of the white and black daisies to be equal. Focusing on the temperature plot, what do you observe in when the daisy albedo is higher than the bare planetary albedo? Equal to the bare albedo? Lower than bare albedo?
   1. **Cooling, no effect, heating.**
   2. Cooling, heating, no effect.
   3. Heating, no effect, cooling.
   4. Heating, cooling, no effect.
4. Experiment with the changing the insulation factor in the Daisyworld model. Which of the following statements are true when the insulation factor is set to zero? (perfect conduction).
5. The area of black and white daisies becomes equal.
6. The areas of black and white daisies are unique.
7. The temperatures of black daisies and white daisies becomes equal.
8. The temperatures of black and white daisies are unique.
9. The albedo difference between black and white daisies exerts no control on the system’s balance.
10. The albedo difference between black and white daisies exerts a strong control on the system’s balance.
    1. I, IV, VI
    2. **I, III, V**
    3. II, IV, VI
    4. II, III, V