Name _____ Teacher _____ Date _____

4.2: Grading the Computer Model for Constant Fluxes Worksheet

*This worksheet has "grading" in the title because at this point, students can be held accountable for correct answers. Level 4 (correct) responses to the questions are in **blue bold italics** below. There are also comments about common Level 2 and Level 3 responses to help you with grading and making decisions about what to emphasize in future lessons.*

Red italics suggest ways to grade student responses by giving them points for correct or partially correct answers. There are 84 points total on this worksheet.

In the Tiny Pool and Flux Game you could investigate some important patterns in how fluxes change the size of pools. But the Tiny Pool and Flux Game didn't have a very realistic ecosystem. Instead of 10 carbon atoms, real ecosystems normally have thousands of kilograms of carbon (and 1 kg of carbon has more than 50,000,000,000,000,000,000 carbon atoms).

A. Collect and record results for Model 1

In this activity, you will investigate patterns in a computer model of a larger ecosystem, with 1000 kg of carbon (though this model is still different from real ecosystems in some important ways. Click the **one-turtle model**:
https://carbontime.bscs.org/sites/default/files/simulations/pool-flux-simulation-updated/index.html

- Two pools:
  - Inorganic carbon (CO_2) in the atmosphere (lavender color)
  - Organic carbon in producers, consumers, decomposers, and soil organic carbon (green color)

  The size of the pools is measured in kilograms (kg). There is always a total 1000 kg in the ecosystem. You can use the sliders to say how much carbon is in each pool. (The graph shows just the organic carbon pool, since the CO_2 pool is always just the difference between the organic carbon pool and 1000 kg.)
- Two fluxes:
  - Photosynthesis changes CO_2 into organic carbon (light blue color in the model, Phs. flux in the table)
  - Cellular respiration by producers, consumers, and decomposers changes organic carbon back into CO_2 (dark blue color, CR flux in the table)

  Fluxes describe how fast carbon moves from one pool to the other, so fluxes are measured in kilograms per year (kg/yr). You can use the sliders to set each flux at any value from 0 kg/yr to 100 kg/yr.

When you run the simulation, you can see both graphs and tables showing how the fluxes and the organic carbon pool change over time. Notice that you can slide the line on the graph to any time, and the table will show the pools and fluxes at that time.

1. Try the first two runs. Use the table on the next page to show the results of different runs. Start with the settings suggested for runs 1 and 2, then try your own settings! Click on the graph to see a sliding line that you can use to get the exact pool sizes for a specific time.
2. For Row 3 try any combination of pools and fluxes that you would like, and record what happens.

3. A challenge for Row 4: Can you come up with different settings for the Photosynthesis and CR fluxes that will produce the same results as Row 2? Record what you tried and the results.
4. Something else to try: Can you leave the starting pool size the same, but change the fluxes so that:
   - The org. (organic carbon) pool reaches 1000 kg in 10 years?
   - The CO_2 pool reaches 1000 kg in 20 years?

   Record the results of your tries on the table.
5. Use the remaining rows of the table to record the results of other runs that you try.

#	Initial setting (0 years)				1 year		5 years		20 years	
	CO_2 pool	Organic pool	Phs. flux	CR flux	CO_2 pool	Org. pool	CO_2 pool	Org. pool	CO_2 pool	Org. pool
1	500 kg	500 kg	50 kg/yr	50 kg/yr	***500***	***500***	***500***	***500***	***500***	***500***
2	500 kg	500 kg	50 kg/yr	70 kg/yr	***520***	***480***	***600***	***400***	***900***	***100***
3	***Answers will vary***									
4	***Answers will vary but results should match row 2***									
5	***Answers will vary but org. pool should reach 1000kg in 10 years***									
6	***Answers will vary but CO_2 pool should reach 1000kg in 20 years***									
7	***Answers will vary***									
8	***Answers will vary***									

1 point for each correct cell. 80 points total.

B. Questions about Patterns

6. What happens if you change the initial settings for pool size, but leave the fluxes the same? Why?

If the fluxes stay the same, the pools will remain at their initial values, because the opposing fluxes are the same (or the net flux is zero).
1 point for correct pattern.

7. What patterns did you notice as you ran the model. Use the space below to explain the patterns you saw in how fluxes can change the sizes of pools (or keep them the same).

Students should describe three patterns:
When opposing fluxes are equal, pool sizes stay the same.
When opposing fluxes are not equal, pool sizes change.
How fast the pool sizes change depends on the difference between the opposing fluxes (or the net flux).
1 point for each correct pattern. 3 points total.