Name _____ Date _____

**Exploring the Nitrogen Cycle**

**Part 1:** During this activity you are a nitrogen atom, discovering the different locations that nitrogen exists in ecosystems. For each step along the journey, write down where you start, what happened to you, where you went, and the chemical formula. Each person in the class will follow a different route. Sometimes, you will get 'stuck' at a particular station and you will remain there for one turn. Write down everything that happens so that you have an accurate record of your journey.

The first line is an example.

| Trip | Starting location | What happened? | Where you went: | Formula and name: |
|---|---|---|---|---|
| *Ex* | *Dead plants and animals* | *The wood burned and I was released into the atmosphere* | *Atmosphere* | *$N_20$*<br><br>*Nitrous oxide* |
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |

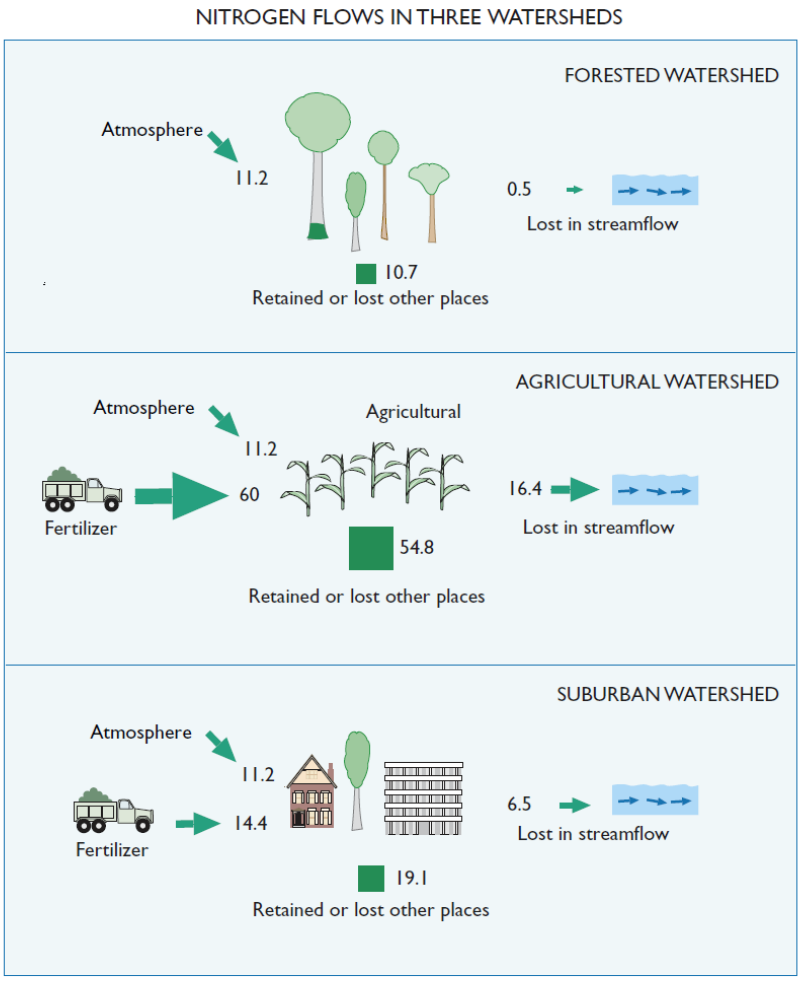
KEY:

| | | |
|---|---|---|
| $N_2$ = nitrogen gas | $NH_3$ = ammonia | $NO_3$ = nitrate |
| $N_2O$ = nitrous oxide | $NH_4$ = ammonium | $NO_2$ = nitrite |

**Part 2**

1. Summarize the processes you took as a nitrogen atom (use the bottom or the back of the next page). It may be helpful to draw your journey as well.

2. Using the visual, answer the questions that follow. These data are from sampling sites in and around Baltimore, MD.




*Data are from: Groffman et al. 2004. Nitrogen fluxes and retention in urban watershed ecosystems. Ecosystems, 7:393-403.*

a. Which watershed had the highest amount of nitrogen input?
___ Forest x Agriculture ___ Suburban

b. Which watershed 'lost' the most nitrogen to the stream?
___ Forest x Agriculture ___ Suburban

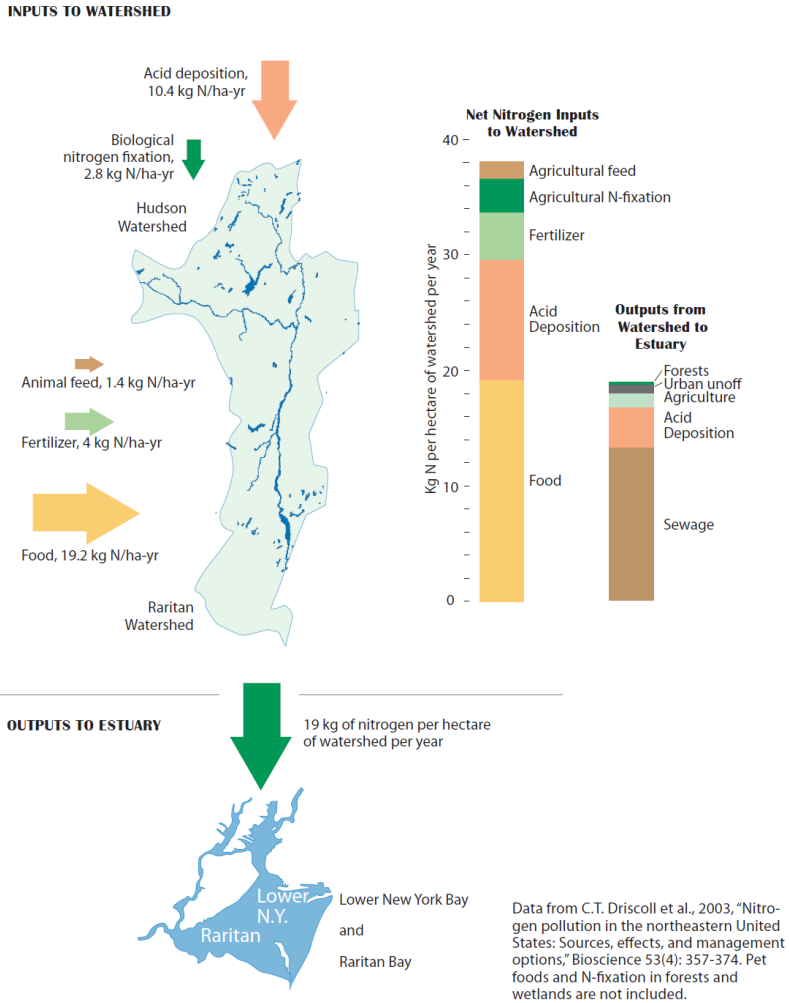
c. Which watershed retained the most nitrogen?
___ Forest x Agriculture ___ Suburban

3. Where did the excess nitrogen come from?
*Excess nitrogen comes from fertilizer inputs, along with atmospheric deposition.*

4. Are there sources of nitrogen missing from this diagram? Explain.
*Additional nitrogen could enter the system in the form of human or animal waste or natural fixation.*

5. Where does the excess nitrogen in a watershed ultimately go?
*Excess nitrogen ultimately goes into the stream, ending up in lakes, groundwater, and the ocean. Plants could take up some of this excess.*

6. Compare the graphic above from a forest, agricultural field, and suburban area with data from the Hudson River watershed below.




a. What is the source of the largest input of nitrogen to the Hudson River watershed?

___ acid deposition ___ biological nitrogen fixation
___ animal feed ___ fertilizer x food

b. How is this different from the diagram of the forest/field/suburbia?
*The largest input was fertilizer, but here the largest input is food.*

c. What is the source of the largest output from the watershed to the estuary?
___ forests ___ urban runoff
___ agriculture ___ acid deposition
x sewage

d. In which system is more nitrogen lost, or exported, to the ecosystem?
___ forest ___ agricultural field
___ suburbia x Hudson River watershed

e. Describe how the nitrogen cycle is different in these two places.
*There is less agriculture in the Hudson River watershed,sothe inputs from food (sewage) are a more important nitrogen source. There is more nitrogen exported to the estuary in the Hudson River than in the systems in Baltimore, MD (19kg/ha/year vs 16.4).*

7. Based on these data and the game, how do people affect the nitrogen cycle?
*People have affected the amount of nitrogen in the ecosystem by adding additional nitrogen in the form of fertilizer, sewage, and acid deposition (caused by the burning of fossil fuels). There is now essentially twice as much nitrogen available on land, leading to many different types of pollution. This includes nitrous oxide (greenhouse gas), nitric oxide (smog), acidification of waterways, and the eutrophication of lakes and coastal systems, among other problems.*