Name _____ Date _____

Hydrofracking Fluids & the Forest

Look at the photo below. This shows how the drilling company, when they were done drilling for natural gas and were left with a lot of wastewater, began spraying that wastewater onto the forest. The bottom picture shows the results of this spraying after one year.

Figure 5.—Land application of drill pit fluids to fluid application site 1, Fernow Experimental Forest, June 2008. Photo by U.S. Forest Service.

Figure 9.—Fluid application site 1, with non-treated forest in background, Fernow Experimental Forest. Photo taken May 17, 2009. Photo by U.S. Forest Service.

1. Scientists observed that there were 115 trees that were visibly damaged in the area where the spraying took place in 2008, and 147 in 2009. Here are the different tree species each year:

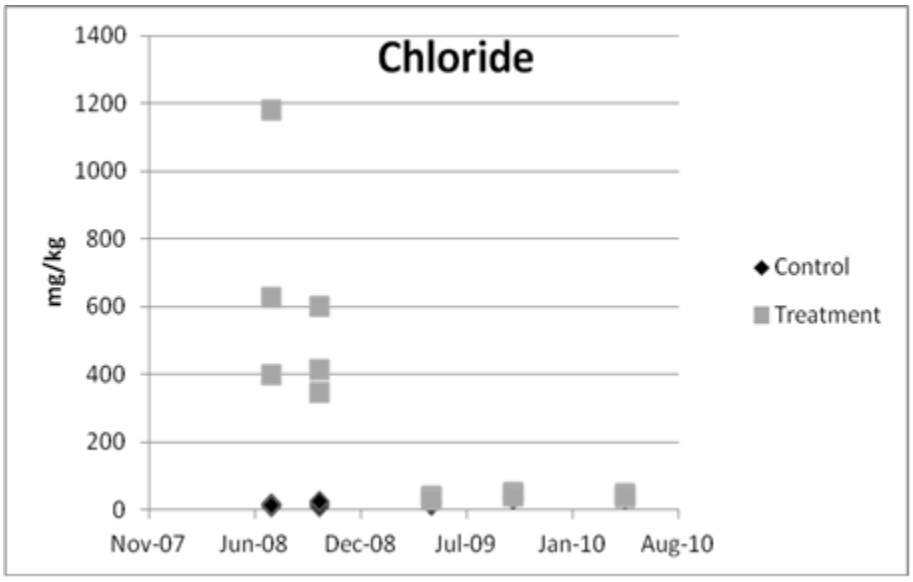
Tree species	Number damaged in 2008	Number damaged in 2009
American beech	57	57
Red maple	29	47
Sassafras	10	10
Northern red oak	6	14
Yellow-poplar	5	6
Sweet birch	4	5
Chestnut oak	1	1
Cucumber tree	1	1
Fraser magnolia	1	1
Downy serviceberry	1	3
Sourwood	0	2
TOTAL	115	147

   a. What trend do you notice between 2008 and 2009?
   Between 2008 and 2009, more trees were damaged. It is unclear from the data set whether these are the same trees or not; however, it seems that all of the tree species experienced the same or more damage between the two years.

   b. What do you expect might happen to the number of damaged trees in 2010? Explain your answer.
   I expect the number of damaged trees to increase, if the current trend continues.

   c. Do these results of tree damage support the claim you made after testing salt pollution on organisms? Explain.
   Answers will vary, but students should be able to connect the results from their experiment with the tree damage above. Depending on the type of experiment the students completed, they might see some similarities between the death of duckweed and the amount of tree damage.

2. Think back to the graphs that you made and discussed in Lesson 2. Here is the chloride graph you investigated earlier in the unit (and remember that there are other variables which showed a similar trend).



a. Describe what happened to the chloride concentrations in the soil of the forest after the application of the flowback water in May of 2008 (treatment):

   Chloride concentrations in the soil of the forest increased in the summer and remained high in the fall of 2008, and then decreased by the summer of 2009.

b. Why do you think there is so much variability between the samples taken in the treatment area of the forest in 2008?

   This variability probably represents the fact that samples were taken throughout the forested area and different amounts of flowback water were applied.

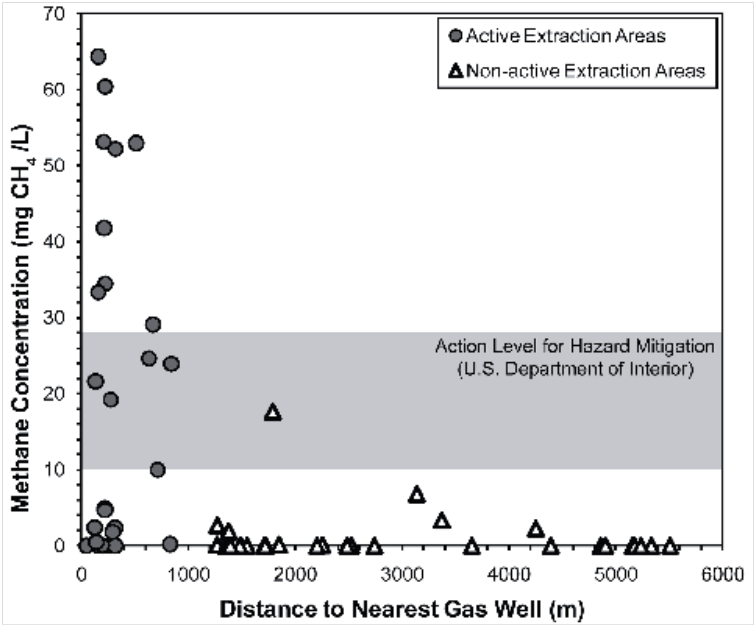
c. How long did it take for the soil chemistry to return to "normal" levels found in the control plot?

   It took one year for the soil chemistry levels to return to "normal".

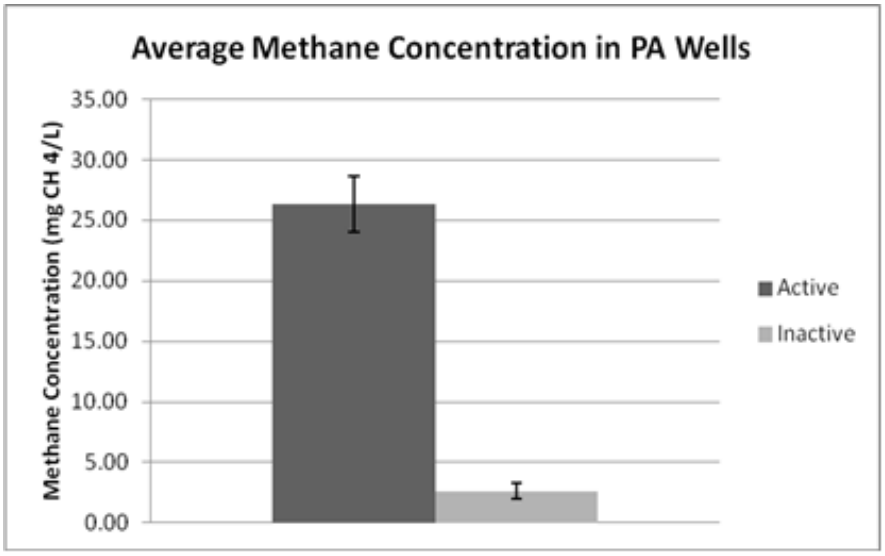
3. Why do you think the trees in the treatment forest (from question #2) continued to die in 2009, even when the contaminants in the soil were "back to normal" values?

   Some trees may take longer to respond to the soil contamination, and once they are killed, they will not recover.

4. Look at the graphs below. Graph A is the same graph you saw in the first lesson, while Graph B shows the same data in a different way: it shows the averaged data and error bars for the active and inactive sampling sites:



Graph A



Graph B

a. Explain the trend you notice in methane concentration.
There is more methane near the active wells.

b. Which graph do you think more clearly shows this trend? Explain.
Graph B more clearly shows this trend, because it gives an overall average of the two types of sampling sites.

c. Complete this table, thinking about the two graphs:

Benefits of the scatterplot (Graph A):	Benefits of the bar graph w/ error bars (Graph B):
Allows you to see all of the data points and shows all of the variability.	More clearly shows a trend and also shows you the range around the mean for each data set.
Drawbacks of the scatterplot (Graph A):	Drawbacks of the bar graph w/ error bars (Graph B):
It is harder to see a trend over time because of all the data points.	You can't see all of the data points.

5. Based on the information you have so far, make a scientific argument (claim, evidence, reasoning) about whether hydrofracking causes ecological harm.

Claim: Make a claim about whether fracking causes ecological harm	*If flowback water from hydrofracking wells is sprayed on forests, the trees will die.*
Evidence: Provide evidence to support your claim	*One hundred forty-seven trees died within the application area after receiving flowback water.*
Reasoning: Explain how your evidence supports your claim	*The trees were killed by the excess salt in the soil.*

6. What else would you like to know about hydrofracking and ecosystems?
   Students should discuss how methane impacts ecosystems, which is not something that this unit covered.

7. Design a study that you would like to conduct to gather additional data about the claim you have stated.
   Answers will vary.