Cary Institute of Ecosystem Studies

Hudson River Water Quality

Sampling Activity

When untreated sewage enters surface waters, not only can it be harmful for wildlife, but it may contaminate our drinking water source or our favorite swimming hole. Major sources of raw sewage contamination in the Hudson River are Combined Sewer Overflows, or *CSO*s. CSOs occur in some cities after heavy rains—sewer systems exceed capacity with the amount of water that comes in to them, so they stop processing waste and instead allow raw sewage to be released into a nearby waterbody. According to Riverkeeper there are 460 CSO outfalls in NYC, 92 in Albany, and dozens more in other Hudson riverfront communities.

We know that CSO outfalls bring a lot of raw sewage into the Hudson River, but do all places along the Hudson River receive about the same amount of contamination or do they differ? One common way that scientists quantify contamination by untreated sewage is by testing for fecal indicator bacteria of the genus *Enterococcus*. Enteroccoci are often found in places where pathogens live—like the human gut.

You have been given three sites along the Hudson River to sample—in Manhattan from the middle of the Hudson by the Battery, and from the pier at 125th St, and from a rowing dock in Albany. Follow the instructions below, and then complete the questions to help you find the answer:

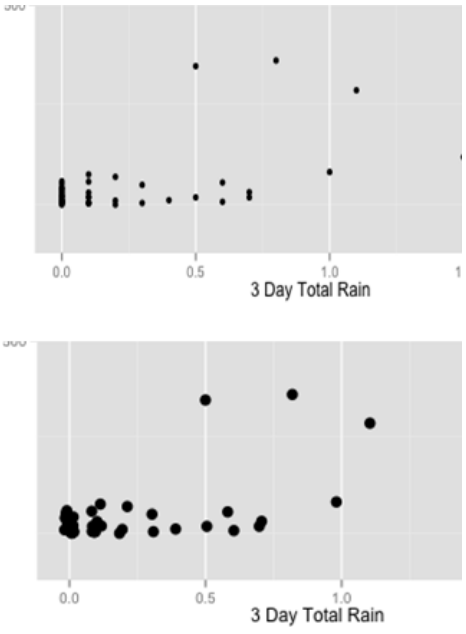
Does the sewage contamination between the three sites differ?

Divvy up tasks in your team, one per person: Sampler, Sample Recorder, & Sample Collector. Then follow the procedure below.

Sampler: Your job is to draw random samples from each site—***without* replacement**. This means you will NOT put the numbers back into the jar after you draw your sample. You'll first draw 3 samples, then 5 more (for 8 total), then 7 more (for 15 total), and finally 10 more (for 25 total).

Sample Recorder: On the graph that was given to you, record the number drawn. You will record each set of sampled data with a different colored pencil, as indicated in this worksheet.

If the number *does not fit on your graph*, put a star over the site above the graph and write the number down. If the number is a *repeat* (say, another zero), you can put a dot right next to the one you made previously. This makes the graph similar to a 'jitter' plot shown at lower right, which allows you to see that there are many similarly-numbered dots in the same column.



Sample Collector: Collect and organize the sampled values, keeping each site's data separate. You'll help ensure the samples are taken and *not* replaced, and have samples available if the sample recorder has a question.

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Procedure

1. Sample 3 from each site, and use the color yellow to complete the following.

   a) Sampler: Sample the designated number of times for that round of sampling.

   Sample Recorder: On the graph provided you, record each sample with a single dot, according to the instructions above.

   Sample Collector: Collect the samples in an organized way.

   b) Decide as a group – What do you think?

   If you were to go sample the water at each of those locations *tomorrow*, how many Enterococci do you think you would find? Record your answer for each site by marking an **X** on the graph for **each site**, using the same color you just sampled with.

   c) Decide as a group – What do you think?

   Which site do you think has the greatest **variability** in *Enterococcus* counts (i.e. changes the most)? **Circle it** beneath the graph on your data sheet.

   d) **How confident are you** in your guesses to parts b & c above? Circle your confidence level below.

Not at all confident A little confident Confident Pretty confident Completely confident

2. Sample 5 more from each site (for a total of eight), using the color orange as you repeat steps 1 (a)-(c). Answer (d) below.

   d) **How confident are you** in your guesses to parts b & c above? Circle your confidence level below.

Not at all confident A little confident Confident Pretty confident Completely confident

3. Sample 7 more from each site (for a total of fifteen), using the color red as you repeat steps 1 (a)-(c). Answer (d) below.

   d) **How confident are you** in your guesses to parts b & c above? Circle your confidence level below.

Not at all confident A little confident Confident Pretty confident Completely confident

4. Sample 10 more from each site (for a total of twenty-five), using the color purple as you repeat steps 1 (a)-(c). Answer (d) below.

   d) **How confident are you** in your guesses to parts b & c above? Circle your confidence level below.

Not at all confident A little confident Confident Pretty confident Completely confident

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Questions

1. Which site had the *most* variability?

2. Which site had the *least* variability?

3. Which of these sites do you think has very different *Enterococcus* counts from the others, if any? Use the graph as evidence as you explain your reasoning.

4. Which of these sites do you think has pretty much the same *Enterococcus* counts as another, if any? Use the graph as evidence as you explain your reasoning.

5. How did the sample variation affect your decision about whether the sites differ in their *Enterococcus* counts?

6. Did your confidence in your estimates change as you increased the number of samples you collected? Why or why not?

7. In today's society, people often want simple, fast, definite answers.
   a. What do you think the *Enterococcus* counts will be like in Albany after the next big rain causes a CSO outfall?

   b. Which do you think is more truthful—a simple, definite answer, or an answer which includes a range of values? Why?

c. How do you think this impacts the way people perceive science-based, data-driven answers?

d. How do you think this may impact what science research receives public funding? Are there pros and cons to this? Explain your reasoning.

8. CSOs are considered a type of point-source pollution and can be remedied by improving wastewater treatment infrastructure. The New York State government in collaboration with several capital region communities have decided to invest $136 million to improve the wastewater treatment infrastructure at Albany area CSO outfall sites. You are tasked with monitoring *Enterococcus* counts in the water in Albany, both before and after the infrastructure improvements in order to learn if the improvements really do improve the local water quality.

   How many samples will you collect, when, and how often? What more information would you like to collect before you submitting your proposed sampling routine?