

SALT MARSHES MATH Lab



"Forests are good natural carbon sinks. Trees take up carbon from the atmosphere, they photosynthesize, they store that carbon, and they turn it into wood. But forests are not the only

ecosystems that store a lot of carbon. In fact, coastal ecosystems — and here I'm thinking mainly of mangroves, salt marshes, and sea grasses — they take up and store large amounts of carbon as well. And I think one of the reasons that these coastal ecosystems are just now being recognized as important carbon sinks is because most of the carbon in these ecosystems is stored below ground in the soils. So it's not in the biomass of the trees the way it is in a forest, where we can see that carbon. In these coastal systems, it's almost entirely below ground where we can't see it. These soils under these coastal ecosystems tend to be several meters deep and they often store carbon that is decades if not thousands of years old." Says a NOAA expert, an ecosystem ecologist and biogeochemist Dr. Ariana Sutton-Grier (Resource: <http://oceanservice.noaa.gov/podcast/may14/mw124-bluecarbon.html>)

One of the ways blue carbon is sequestered from the atmosphere by the marshes (at rates ten times higher than most forested systems) is by “sucking in” the carbon dioxide through rain water and air and storing it in the spongy bay mud, called peat, at 2-6 feet deep. The bay mud has been storing CO₂ as long as it existed. If disturbed or destroyed, they release the carbon dioxide back into the atmosphere.

So, how does the rain water get to the peat? The ecosystem depends on its many habitants to achieve this. Fiddler crabs are one of these organisms. They live in large colonies and burrow holes 30.5 cm to 92 cm deep, thus allowing air and rain water to reach the depths of peat, allowing spongy peat to absorb the water. These crabs ingest particles of sand and mud and they use their mouths to scrape up the food materials from the sediment and then deposit the sediment back on the ground in sand pallets (they look like small pyramids of sand balls). One fiddler crab consumes 0.4 grams of food materials per 6 hours. During this process they keep the marsh healthy by: (1) allowing the peat to “breathe”; and (2) controlling the spread of bacteria (food material: 25% fungi, 33% diatoms, 20% vascular plants; 20% unknown materials). (http://animaldiversity.ummz.umich.edu/accounts/Uca_pugilator/)

Fiddler crabs live in colonies. One of the way you can identify a male crab from a female is by brighter coloration and the large pincer that is at least four times larger than the other. During a research field trip, a group of scientists estimate that the crabs live 25-30 meters away from the water's edge. They captured several fiddler crabs, recorded several measurements and released all the crabs.

Math Skills Practice:

Refer to the introductory text, figures 1, 2, 3 to answer the following questions:

Question	Answer
1. Based on the 1m grid in Figure 3, estimate the number of fiddler crab burrows per square meter.	1. _____
2. Assume that these burrows are cylindrical tubes. Calculate the minimum amount of rain water one burrow holds in cubic cm, cm^3 .	2. _____
3. Calculate the maximum amount of rain water one burrow holds, in cubic cm, cm^3 .	3. _____
4. Based on your answers to questions 1 and 2, calculate the minimum amount of rain water these burrows allow to sip into peet per square meter.	4. _____
5. Based on your answers to questions 1 and 3, calculate the maximum amount of rain water these burrows allow to sip into peet per square meter.	5. _____
6. How many crabs are there in the 1 m square?	6. _____
7. How much food material, in grams, will a colony of crabs occupying 100 meters of marsh shore line consume in a 6 hour period?	7. _____
8. How much of the fungi, in grams, does the colony consume in the 6 hour period?	8. _____
9. How much of the diatoms, in grams, does the colony consume in the 6 hour period?	9. _____
10. What is the least amount of sand/sediment does the colony "clean" in a 6 hour period? (either in grams or cm^3)	10. _____
11. Based on the data in the Figure 1, how many fiddler crabs were caught?	11. _____
12. What percentage of the caught crabs were males?	12. _____
13. What percentage of the caught crabs were females?	13. _____
14. What is the average length of a male fiddler crab pincer?	14. _____
15. What is the average length of the regular male claw?	15. _____
16. What is the average width of prosoma of a female crab?	16. _____
17. What is the average width of prosoma of a male crab?	17. _____
18. What is the average height of prosoma of a female crab?	18. _____
19. What is the average height of prosoma of a male crab?	19. _____
20. Which gender crab was wider?	20. _____
21. By how much? (in cm)	21. _____
22. What is the ratio of left-handed crabs (L) to right-handed ones (R)?	22. _____
23. What percent of male crabs were left-handed?	23. _____
24. What is the ratio of male crabs to females?	24. _____
25. What percent of crabs with width of 1.2 cm are males?	25. _____

Chincoteague Field Station, VA; May 14, 2014 data:

Male (L/R)/Female	Pincer leg length (m)	Width of Prosoma (cm)	Height (cm)
Female		0.9	0.7
Female		1	0.8
Female		1.1	0.7
Female		1.1	0.7
Female		1.1	0.6
Female		1.2	0.8
Female		1.7	1.1
L	1	1.2	0.8
L	1.7	1.5	1.1
L	2.9	1.7	1.2
L	3	1.6	1.1
L	3.1	1.8	1.3
R	1.2	1.2	0.8
R	1.3	1.2	0.8
R	1.5	1.2	0.8
R	1.5	1.4	0.8
R	1.8	2.8	1.3
R	2.2	1.6	1.2
R	2.2	1.6	1.1
R	3.2	2.2	1.3
R	3.3	1.9	1.2

Figure 1: Wallops Island Salt Marshes Data

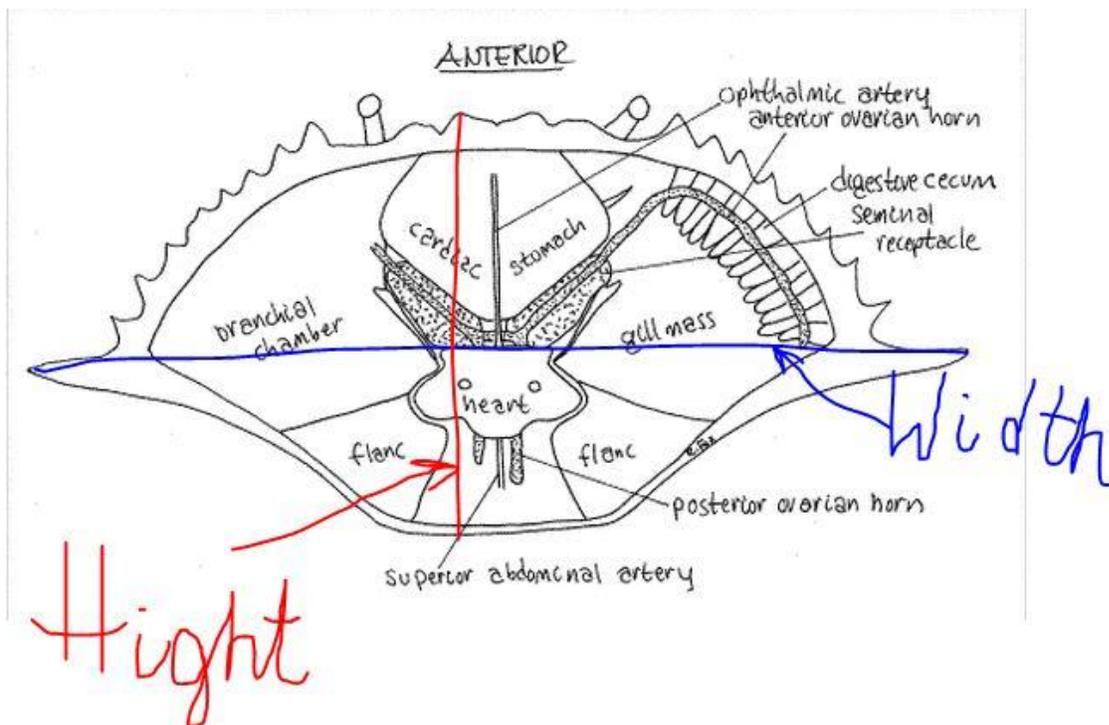


Figure 2: Fiddler Crab Physiology



Figure 3: 1 square meter grid with 25 cm increments of fiddler crab burrows, Wallops Island Salt Marsh, 5/14/2014

Proposed discussion topics / Optional writing assignments

1. What is positive economic importance of salt marshes to humans?
2. What is negative economic importance of salt marshes to humans?
3. What have you learned about the fiddler crabs and their role in the ecosystem of salt marsh?
4. What new words did you add to your vocabulary?

Question

Answer

- Based on the 1m grid in Figure 3, estimate the number of fiddler crab burrows per square meter.
1. ≈ 32 burrows
- Assume that these burrows are cylindrical tubes. Calculate the minimum amount of rain water one burrow holds in cubic cm, cm^3 .
2. $\pi*(1.3/2)*30.5 \approx 62.282 \text{ cm}^3$
- Calculate the maximum amount of rain water one burrow holds, in cubic cm, cm^3 .
3. $\pi*(1.3/2)*92 \approx 187.867 \text{ cm}^3$
- Based on your answers to questions 1 and 2, calculate the minimum amount of rain water these burrows allow to sip into peet per square meter.
4. $32*62.282 \approx 1,993 \text{ cm}^3$
- Based on your answers to questions 1 and 3, calculate the maximum amount of rain water these burrows allow to sip into peet per square meter.
5. $32*187.867 \approx 6,012 \text{ cm}^3$
- How many crabs are there in the 1 m square?
6. ≈ 32
- How much food material, in grams, will a colony of crabs occupying 100 meters of marsh shore line consume in a 6 hour period?
7. $\leq 32*(100*30)*0.4 = 38,400$ grams
- How much of the fungi, in grams, does the colony consume in the 6 hour period?
8. $\leq 0.25*38,400 = 9,600$ grams
- How much of the diatoms, in grams, does the colony consume in the 6 hour period?
9. $\leq 0.33*38,400 = 12,672$ grams
- What is the least amount of sand/sediment does the colony "clean" in a 6 hour period? (either in grams or cm^3)
10. $\leq 2*38,400 = 76,800$ grams
- Based on the data in the Figure 1, how many fiddler crabs were caught?
11. 21 crabs
- What percentage of the caught crabs were males?
12. $14/21 = 0.6666 \approx 66.7\%$
- What percentage of the caught crabs were females?
13. $7/21 = 0.3333 \approx 33.3\%$
- What is the average length of a male fiddler crab pincer?
14. ≈ 2.14 cm
- What is the average length of the regular male claw?
15. $\approx 1/4*2.14 = 0.535$ cm
- What is the average width of prosoma of a female crab?
16. ≈ 1.16 cm
- What is the average width of prosoma of a male crab?
17. ≈ 1.64 cm
- What is the average height of prosoma of a female crab?
18. ≈ 0.77 cm
- What is the average height of prosoma of a male crab?
19. ≈ 1.06 cm
- What gender crab was wider?
20. Males are wider
- By how much? (in cm)
21. ≈ 0.48 cm
- What is the ratio of left-handed crabs (L) to right-handed ones (R)?
22. 5 : 9
- What percent of male crabs are left-handed?
23. $5/14 \approx 0.357$ or 35.7%
- What is the ratio of male crabs to females?
24. 14:7 or 2:1
- What percent of crabs with width of 1.2 cm are males?
25. $4/5 = 0.80$ or 80%