**Outcomes of Mass Audubon’s Salt Marsh Science Project**

* Coastal Science Conference (November, Newburyport) – Students create a presentation and share their ideas with other students and scientists.
* Differentiated Instruction – Allows students with special needs to be on an even playing field as there are many ways to participate.
* Reflect on connections to your school/organization’s mission statement
* Student self-assessment of the processes they used and how active they were in their learning (not just their final grade!)
* Connections to current and future Massachusetts Science, Technology Engineering, and Mathematics Frameworks (Mass version of NGSS) (see below)
* Connections to Common Core ELA (see below) on the salt marsh science web site there are links to related journal articles to enhance non-fiction reading skills. <http://www.massaudubon.org/saltmarsh>
* Connections to 21st Century Skills (see below)
* Develop a sense of STEWARDSHIP in our next generation

**Connections to the Massachusetts Science, Technology, Engineering, and**

**Mathematics Frameworks (Mass version of NGSS)**

**Grade 7 Life Science Ecosystems: Interactions, Energy, and Dynamics**

MS-LS2-2. Describe how relationships among and between organisms in an ecosystem can be competitive, predatory, parasitic, and mutually beneficial and that these interactions are found across multiple ecosystems.

MS-LS2-4. Analyze data to provide evidence that disruptions (natural or human-made) to any physical or biological component of an ecosystem can lead to shifts in all its populations.

MS-LS2-5. Evaluate competing design solutions for protecting an ecosystem. Discuss benefits and limitations of each design.

MS-LS2-6(MA). Explain how changes to the biodiversity of an ecosystem—the variety of species found in the ecosystem—may limit the availability of resources humans use.

**Grade 8 Life Science from Molecules to Organisms: Structures and Processes**

MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

**High School Earth and Space Sciences - Earth and Human Activity**

HS-ESS3-3. Illustrate relationships among management of natural resources, the sustainability of human populations, and biodiversity.

HS-ESS3-5. Analyze results from global climate models to describe how forecasts are made of the current rate of global or regional climate change and associated future impacts to Earth systems.

**High School Biology - Ecosystems: Interactions, Energy, and Dynamics**

HS-LS2-6. Evaluate the claims, evidence, and reasoning that in stable conditions the dynamic interactions within an ecosystem tend to maintain relatively consistent numbers and types of organisms even when small changes in conditions occur but that extreme fluctuations in conditions may result in a new ecosystem. Analyze data to provide evidence that ecosystems with greater biodiversity tend to have greater resistance and resilience to change.

HS-LS2-7. Analyze direct and indirect effects of human activities on biodiversity and ecosystem health, specifically habitat fragmentation, introduction of non-native or invasive species, overharvesting, pollution, and climate change. Evaluate and refine a solution for reducing the impacts of human activities on biodiversity and ecosystem health.

**Connections to Common Core ELA**

**Grade 6-8 Literacy**

[CCSS.ELA-Literacy.RST.6-8.3](http://www.corestandards.org/ELA-Literacy/RST/6-8/3/) Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks

[CCSS.ELA-Literacy.RST.6-8.9](http://www.corestandards.org/ELA-Literacy/RST/6-8/9/) Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

**Grade 9-10 Literacy**

[CCSS.ELA-Literacy.RST.9-10.3](http://www.corestandards.org/ELA-Literacy/RST/9-10/3/) Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

[CCSS.ELA-Literacy.RST.9-10.9](http://www.corestandards.org/ELA-Literacy/RST/9-10/9/) Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Grade 11-12 Literacy

[CCSS.ELA-Literacy.RST.11-12.3](http://www.corestandards.org/ELA-Literacy/RST/11-12/3/) Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

[CCSS.ELA-Literacy.RST.11-12.9](http://www.corestandards.org/ELA-Literacy/RST/11-12/9/) Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

**Writing Grades 6-12**

[CCSS.ELA-Literacy.WHST.1](http://www.corestandards.org/ELA-Literacy/WHST/6-8/1/) Write arguments focused on discipline-specific content

[CCSS.ELA-Literacy.WHST.2](http://www.corestandards.org/ELA-Literacy/WHST/6-8/2/) Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

[CCSS.ELA-Literacy.WHST.6](http://www.corestandards.org/ELA-Literacy/WHST/6-8/6/) Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently

[CCSS.ELA-Literacy.WHST.7](http://www.corestandards.org/ELA-Literacy/WHST/6-8/7/) Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

**Reading Grades 6-12**

[CCSS.ELA-Literacy.RI.11-12.1](http://www.corestandards.org/ELA-Literacy/RI/11-12/1/) Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

[CCSS.ELA-Literacy.RI.11-12.2](http://www.corestandards.org/ELA-Literacy/RI/11-12/2/) Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.

[CCSS.ELA-Literacy.RI.11-12.3](http://www.corestandards.org/ELA-Literacy/RI/11-12/3/) Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text.

**Connections to 21st Century Skills**

Civic Literacy

* Understanding the local and global implications of civic decisions

Environmental Literacy

* Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water and ecosystems
* Demonstrate knowledge and understanding of society’s impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
* Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
* http://ipswichschools.rubiconatlas.org/common_images/clear.gif?v=Atlas8.0.3.240Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

Work Creatively With Others

* View failure as an opportunity to learn; understand that creativity and innovation is a long-term, cyclical process of small successes and frequent mistakes

Critical Thinking and Problem Solving

* Use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation

Systems Thinking

* Analyze how parts of a whole interact with each other to produce overall outcomes in complex systems

Make judgments and decisions

* Interpret information and draw conclusions based on the best analysis
* Reflect critically on learning experiences and processes

Solve Problems

* Identify and ask significant questions that clarify various points of view and lead to better solutions

Communication and Collaboration Communicate Clearly

* Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts

Collaborate with Others

* Demonstrate ability to work effectively and respectfully with diverse teams
* Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal
* Assume shared responsibility for collaborative work, and value the individual contributions made by each team member

 Produce Results

* Demonstrate additional attributes associated with producing high quality products including the abilities to: - Work positively and ethically - Manage time and projects effectively - Multi-task - Participate actively, as well as be reliable and punctual - Present oneself professionally and with proper etiquette - Collaborate and cooperate effectively with teams - Respect and appreciate team diversity - Be accountable for results

Transect Data Analysis

By Lori La France, Ipswich High School

Site:

Was this site restored? If yes, what year? Herbicide used?

Circle whether the *Phragmites* has spread or retreated from previous years.

**Transect #**

T Spread Retreated Stayed the Same Comments:

T Spread Retreated Stayed the Same Comments:

T Spread Retreated Stayed the Same Comments:

Does this site have a reference transect? If yes: this should remain the same because it was unaffected by the culvert. Has it remained the same?

Look at the *Phragmites* % monoculture graph. Is the % monoculture increasing or decreasing?

T Increasing Decreasing

T Increasing Decreasing

T Increasing Decreasing

Reference T Increasing Decreasing

Look at *Phragmites* height graphs. Based on these graphs, would you say *Phragmite* is stressed or thriving here? Stressed Thriving

Because:

Look at the salinity data from the same site.

Overall, is salinity Low Medium High Super High

There are lots of ways to analyze salinity… What patterns do you see?

Please give some possible explanations for the salinities we found.

Is there any relationship between salinity and spread or retreat of *Phragmites* at this site? Compare all the transects.

Has there been any significant change in the distribution of native plants (all plants except *Phragmites*, purple loosestrife, and perennial pepperweed)?

**Is the salt marsh healthier now that we have restored tidal flow?**

Check the things below that would indicate a healthier salt marsh:

Higher salinity Lower salinity

More invasive species Less invasive species

Taller *Phragmites* Shorter *Phragmites*

More native plants Less native plants

More wet, dead areas Less wet, dead areas

More fish Less fish

Hypothesis: Replacing the culvert (pipe under the road) would lead to reduced *Phragmites*, and improve the health of the marsh.

Does the data support this hypothesis?

What evidence do you see? (If the data gives mixed results, please describe.)

**Is the salt marsh healthier now that we have restored tidal flow?**

Check the things below that would indicate a healthier salt marsh:

Higher salinity \_\_\_\_x\_\_\_\_\_\_\_\_ Lower salinity \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

More invasive species \_\_\_\_\_\_\_\_\_ Less invasive species \_\_\_\_\_\_x\_\_\_\_\_

Taller *Phragmites* \_\_\_\_\_\_\_\_\_\_\_\_\_ Shorter *Phragmites* \_\_\_x\_\_\_\_\_\_\_\_\_

More native plants \_\_\_\_x\_\_\_\_\_ Less native plants \_\_\_\_\_\_\_\_\_\_\_\_\_

More wet, dead areas \_\_\_\_\_\_\_\_\_\_ Less wet, dead areas \_\_\_\_\_x\_\_\_\_\_\_\_

More fish \_\_\_\_\_\_\_\_x\_\_\_\_\_\_\_\_\_\_\_\_ Less fish \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Hypothesis: Replacing the culvert (pipe under the road) would lead to reduced *Phragmites*, and improve the health of the marsh.

Does the data support this hypothesis?

What evidence do you see? (If the data gives mixed results, please describe.)

**Salt Marsh Science Rubric**

Student Name:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| CATEGORY | 4 | 3 | 2 | 1 |
| In the marsh  4x pts=16 max | Worked the entire day going above expectations. | Worked the entire day . | Worked most of the day but fizzled out. | Did not work much. |
| In preparation for the conference  4x pts=16 max | Took responsibility for your part of the project and added a lot of your own touches. | Took responsibility for your part of the project. | Did some work when others asked you to. | Did not contribute. |
| At the conference  2x pts=8 max | Took on a speaking role and/or answered questions. | Helped out in some way other than speaking. | Was a polite and respectful audience member. | Was not listening during presentation. |
| Willingness to help  wherever needed  3x pts=12 max | Cooperative and agreeable. | Cooperative | Did what was asked though it was evident you didn’t want to. | Did not do what was asked. |
| Staying on task  2x pts=8 max | Worked without being prompted until job was done. | Worked on task most of time. | Worked when asked to. | Did not work. |
| TOTAL \_\_\_\_\_\_\_\_  Out of 60 |  |  |  |  |

Salt Marsh Project Self Assessment

NAME:

What grade should you get on the salt marsh project? Circle and add + or – if needed.

A B C D F

Justify your choice:

Describe what you contributed on the day we collected data in the marshes:

Describe your role in the classroom helping to prepare for the conference:

Describe what you did at the conference:

Anything else you would like to add?

**Sample School Mission Statement Reflection:**

**By Lori La France**

Ipswich High School Mission Statement Reflection

NAME:

*Ipswich High School is a collaborative community that fosters equity among learners. We engage in the personalized acquisition of the skills and knowledge essential to becoming successful, contributing, and responsible citizens.*

Please reflect on how your school mission statement relates to your experience with Mass Audubon’s Salt Marsh Science Project and comment below.

Quiz after Salt Marsh Field Trip NAME:

1. Would you expect to find higher salinity in the shallow, medium, or deep wells?

2. Why?

3. Would you expect to find higher salinity in the area where *Phragmites* grows or where it doesn’t grow?

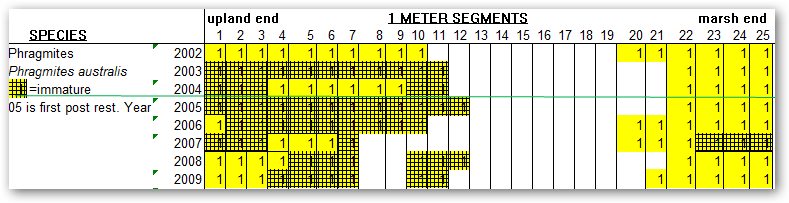
4. Why?

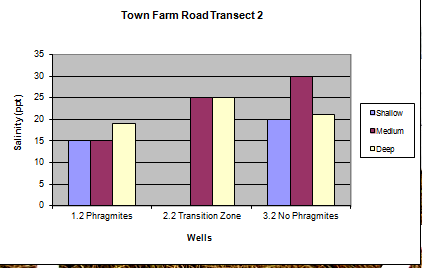
5. How can you tell if *Phragmites* is mature?

6. List three native salt marsh plants.

7. What was the purpose of increasing the size of the culvert?

8. Describe the trend in *Phragmites* shown in this graph.





9. Give 2 reasons why the salinity readings in this graph are at these levels.

10. What topographic feature might have an effect on the salinity levels at Jeffrey’s Neck Road?

**Quiz after Salt Marsh Field Trip**  **ANSWER SHEET**

1. Would you expect to find higher salinity in the shallow, medium, or deep wells?  
Student responses may vary. See explanation below.

2. Why?

**Where is the salinity the greatest, in the shallow, medium, or deep well?** The answer to this question is not simple. This is why we are taking measurements! These salinity measurements are often different than our predictions.

**Physical Properties of water:** Salt water is denser than fresh water, so, we might expect the deepest well to therefore have the greatest salinity.

**The impact of the water cycle:** The water cycle also has an impact on salinity. The shallow well seems to change the most seasonally. In the spring, following a lot of rain and snowmelt, the shallow well often has the lowest salinity. However in the fall, following a lot of evaporation during the summer, the shallow well often has the highest salinity. Evaporation increases salinity, as water evaporates, leaving more concentrated salt. Precipitation decreases salinity, as increased water dilutes the salt.

**The impact of groundwater:**

The soil type, and proximity to the upland also impact salinity levels. If we get the lowest salinity measurements in the deep well, then it is likely that groundwater is coming into play. A freshwater lens may be impacting the deep well.

3. Would you expect to find higher salinity in the area where *Phragmites* grows or where it doesn’t grow?

4. Why?

Salt marshes are flooded twice daily by tidal water from the ocean. This salty water advances up the creeks. Thus we expect that salinity is highest closest to the creek, at station 3. Also, *Phragmites* has a harder time growing in higher salinities. It typically grows taller, closer to the upland edge, and shorter *Phragmites* in the transition zone may be an indication that the *Phragmites* is being stressed by salinity. Based on these ideas, one might typically expect that the station 1 would have the lowest salinity, and station 2 is in between.

5. How can you tell if *Phragmites* is mature?

It has a tassel, or seed head at the top.

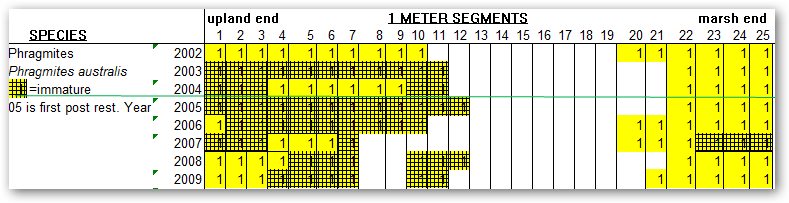
6. List three native salt marsh plants.

Three major salt marsh plants are salt marsh cordgrass, salt marsh hay, black grass, etc.

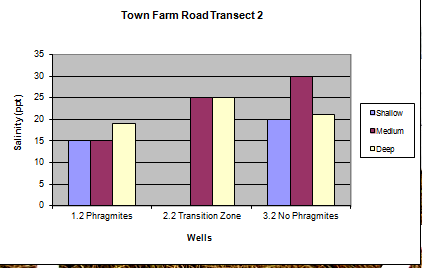
7. What was the purpose of increasing the size of the culvert?

The goal is to improve the health of the salt marsh. To increase tidal flow from the ocean, to reduce *Phragmites australis*, and improve biodiversity. In some cases it also allows the salt marsh to drain better.

8. Describe the trend in *Phragmites* shown in this graph.



*Phragmites* has reduced by two meters in the area in meters 0-13 following restoration. More *Phragmites* is immature in this region compared to meters 20-25. Overall there is not a lot of change before and after restoration.



9. Give 2 reasons why the salinity readings in this graph are at these levels.

Salinity is lower in the area closer to the upland, with *Phragmites*. It is higher in the areas closer to the creek (transition and no *Phragmites*.

10. What topographic feature might have an effect on the salinity levels at Jeffrey’s Neck Road?

Steep slopes may bring increased fresh water to the areas closest to the upland.