Statement of Interest - Over the course of my final three semesters at the University of Connecticut, I want to explore the question of how the historical and modern development of railways along the Connecticut coast impact the health and extent of wetlands within their vicinity. This project is the perfect integration of the double degree I am working towards: a degree in Marine Science (MARN) and a degree in Maritime Studies (MAST). The impact of railways on the function and extent of salt marshes intrigues me, a habitat central to the interconnecting functions of the local environment, and an ecosystem which has retreated from Long Island Sound drastically over the past 200 years (Basso et al., 2005).

Several courses for my Maritime Studies degree detailed how the construction of rail lines was essential to the development of New England, including the historical and economic ramifications of extensive transportation, contrasting accounts of the undisturbed coastal ecosystem recorded by European settlers exploring Long Island Sound. Over the past 20 years, researchers have recognized how people fail to see long-term effects of development on native biota, or to realize the negative impact of losing these habitats on our societal well-being. These studies showcase how society loses the collective memory of what our environment once looked like over time; leading to the notion that our own lifetime of experiences with this habitat reflects the limits of the ecosystem's change. Dubbed the 'shifting baseline', this analytical approach offers new opportunities to understand how Connecticut's shoreline has changed (Pauly, 1995). I believe studying science and history together provides the perspective needed to understand change and combat the impact of shifting baselines. Comparing historical knowledge of marshes with science facts regarding the importance of marsh ecosystems, I realized the relationship would be fascinating to explore. The role which marshlands play in nurturing important resource

species, as a vital part of inter-ecosystem dynamics, and as a beloved part of the beauty of New England, means that the disappearance of marshlands is an issue which warrants further study.

I have had an interest in wetlands my entire life, growing up on the coast of Long Island Sound and admiring the myriad of birds which live on the marshes. During my sophomore year I took a Marine Ecology course which focused on different vital coastal ecosystems such as salt marshes. As part of the coursework, we spent extensive time on the Barn Island marshes in Stonington studying *Spartina alterniflora* salt grass, which acts as a foundation species in the marsh. The culmination of the course was student-designed research experiments concerning an aspect of the local environment, wherein I examined the impact of coastal erosion on *Spartina* marshes. Over the course of the semester, another student and I assessed the Barn Island marsh for *Spartina* density and designed a wave action simulation system in the campus laboratory to study the erosion of *Spartina* grasses and associated sediments. From this endeavor, I gained experience with the salt marshes of the region, both in understanding their dynamics and of research design and methods. This study did however raise questions about the impact of specific developmental factors on erosion or decay of marshlands, with railways being one such factor.

In addition to current ecosystem structure and function, my curiosity also draws from the region's history. As part of my former position at Mystic Seaport Museum working as a historical interpreter, I had the opportunity to learn about railway expansion and the influence of that transport system on the global economics of the period, built upon during classes I took such as Work and Workers in American Society. I deepened my understanding of local history working on the Blue Heritage Trail Project, where I learned about the expansive development of the 19th century through historical research on the town of Groton. Through that research, I came across a variety of sources for old topographic surveys and maps of the local coastline as well as

some of the details of the intermittent construction of sections of the northeastern railway corridor, which showcased the drastic and sudden development of the coast. My interest in local history led me to books containing information about railway construction, as well as the longer-term consequences of development which would inform this project. Throughout these studies, I wondered if there were specific connections between railways and the loss of wetlands habitat.

Combining my historical interest in human developmental impacts and ecological concern for marsh habitats, studying the railway impact on salt marsh health is a perfect beginning for a career in historical ecology, with a particular focus on wetland ecosystems and the coast. One of my career goals is to use a knowledge of both marine ecological science and coastal history to inform and guide habitat restoration using methods such as living shoreline installation and marsh sediment nourishment, and find innovative ways to lessen human impact on critical environments which are crucial in an era where coastal erosion is a growing concern. This project will combine a historiographic study of railway development in connection to wetlands retreat and degradation with a scientific study focused on how railways currently impact the ecological function of wetlands in terms of biodiversity and other indicators. The intersection of historiography and ecology is an interesting niche field, but the impacts of railway development on natural environments in specific with that inter-discipline is unique.

The classes I am prepared to enroll in as I continue my undergraduate career, in tandem with independent research and the help of my advisors, will help me learn more about the intersection of historical railway development and the impact on salt marsh integrity and habitat status. The marine science classes for my B.S. degree are related to sedimentary transport and coastal ecosystems, the same topics I will deal with through my project. The majority of the maritime studies classes will be related to analysis of historical sources and how legal policy

regulates marine environments. These subjects will enhance my understanding of topics relevant to my project, in turn, the practical research for my project will reinforce my classroom learning.

Learning Plan - For the remainder of my undergraduate career, I intend to maximize the number of classes related to both coastal ecosystems and history, within the confines of the requirements of completing a double degree. Since my focus in higher education has been to create an interdisciplinary approach to marine conservation and history, my learning objectives are to explain the interconnected topics related to marshes and their history along the coast. One such learning objective is to be able to analyze sedimentary transport within wetland ecosystems and how that transport may be impacted by coastal erosion exacerbated by climate change. In context to the history of coastal ecosystems and their relation to human development, my major learning objective is to synthesize the historical patterns of coastal development through the 19th and early 20th centuries and their connection to environmental changes, with a focus on how those shifts continue to the present day. Research of historical patterns in coastal development as well as sedimentary transport within wetlands will enable me to tackle the question of how the development of railways has impacted and continues to impact salt marshes.

To facilitate these learning objectives, I have attempted to choose classes which cover the science related to marsh dynamics or the history of coastal development. Environmental Reaction and Transport (MARN 3003Q), Science and the Coastal Environment (MARN 4002), and Coastal Circulation and Sediment Transport (MARN 3060) relate to the dynamics of coastal ecosystems to inform my science objectives. Classes like Measurement and Analysis in Coastal Ecosystems (MARN 4001) and Remote Sensing of Marine Geography (MARN 3505) will help me analyze the geographies of those same ecosystems. The maritime studies courses, such as the Capstone Seminar (MAST 4994W), Maritime History (MAST 3995), and Marine Environmental

Policy (MAST 2300E), will allow me to explore the historical patterns of development alongside the issues associated with governance of coastal environments such as marshes.

Statement of Problem **–** The project I intend to pursue over the final three semesters of my undergraduate degree will combine historical research with scientific field study, attempting to provide an interdisciplinary view on the issue of railway impacts on wetlands. In pursuit of that interdisciplinary outlook, the project will deliver three separate products by the end of the project's timeline, one which is focused on the historical impact and one which is focused on the results of scientific testing on the marshes of the region. I feel that without the historical perspective it is much easier to misunderstand the significance of how humans have changed local ecosystems, and by tying an understanding of historical change to ecological function, society is better informed and prepared for a rapidly changing world. To summarize the historical research, the final product will be a long form scholarly humanities essay, with scientific knowledge informing the background of a thesis based in analysis of historical surveys compared against period sources. Towards the end of the scientific field study, I will produce a journal article, or a summary of the original scientific research, based upon more than a year of field testing for indicator variables of wetlands health and the impacts of railways on water quality and flow. This scientific paper will have some review of previous research that relates to the topic as well, although it will primarily contain the results of my field studies. In order to finalize the interdisciplinary view across the entire project, I will conclude with a reflective essay which will connect the other two products in depth. These three products will address how the historical and modern development of railways along the Connecticut coast impact the health and extent of wetlands within their vicinity. The historical essay will discuss the change over time for wetlands in the vicinity of the railways and the scientific paper will showcase the

modern-day impact on marshes. The reflective essay will present my personal, interdisciplinary approach to the subject by tying the science research to the historical perspective.

Review of Scholarly Literature – The status of Long Island Sound's marshes, and New England in general, have been the subject of analysis and study for decades. In an article published in 2005, K. Bromberg and M. Bertness reconstructed the historical coverage of natural salt marshes across most of New England utilizing historical maps, compared against data found in public geographic information sets (Bromberg & Bertness, 2005). Though the primary focus of the study was not on Connecticut, the analytical methods in the paper are useful for a local coastline study. The metrics used to evaluate tidal wetlands for my proposal are based on those of Kenneth Raposa and his colleagues in 2018, standardizing methods used to analyze restoration efforts of local wetlands based on indicators of marshland health (Raposa et al., 2018).

In 2015, a report released by the U.S. Fish and Wildlife Service conducted a 130-year assessment of the change in tidal wetlands along Long Island Sound, indicating large losses of marshland in Connecticut and New York (Basso et al., 2015). This assessment acknowledges the overlapping nature of stressors on marshes in the region, providing valuable information on the variety of factors which impact wetlands health and extent. Some of the foundational resources for the historical essay will be historical topographic surveys and maps of Connecticut, many of which were published by the U.S. Geological Survey and can be found through the Perry-Castaneda Library Map Collection. Additionally, the Sanborn Insurance surveys which can be found in several local public libraries will help account for marsh coverage in the 1920s.

The contribution of this project to the field would be multifaceted. The project includes conducting an analysis of change in salt marshes of Connecticut with context to the development

of railways coupled with a year and a half study on the status of wetlands impacted by railways. This would bring new focus to the issue of railways acting as a factor impacting wetlands.

Methods and Theoretical Approach **–** The goal for this project is to analyze the historical and current coverage of Connecticut salt marshes impacted by railway lines, with a scientific study of the ecological status of a subset of these marshes. The goal for the scientific study is as follows: to determine the relative biotic and abiotic environmental parameters of marshes in the vicinity of railways compared to reference sites, which are marshes without proximity to railways. The final article will summarize the indicator and parameter results collected across the three semesters, comparing parameters for railway-impacted marshes and non-railway-impacted marshes. The necessary stages of the project being:

- To identify sections of salt marsh within the vicinity of ground level railroad tracks (i.e. the Shoreline East railway) and measure their proximity to the railway.
- To photograph each site and research their land use history, with preliminary measurements to assess possible study sites. The ecological measurements would include water quality and habitat metrics, such as extent of marsh area (Raposa et al., 2018).
- To conduct wildlife surveys and habitat cover surveys of each marsh site, taking note of endangered and invasive species found. The percent cover of dominant vegetation versus invasive vegetation will also be a useful metric to measure. These measurements will allow for analysis of species richness and community composition, indicators of biodiversity and ecosystem health. These biotic indicators will be assessed for each site over three semesters based on monthly data, to show seasonal change in parameters.
- To analyze the abiotic parameters, beginning with placing water level/pressure sensors in the marsh to see environmental impact from tidal restrictions, alongside water sampling

for dissolved oxygen testing. Analyzing pore water salinity through spot checks, alongside water loggers measuring marsh surface inundation, groundwater depth, and maximum high tide within the marsh are examples of the abiotic indicators to monitor.

Although many indicators would be taken on a monthly basis, like the biotic surveys determining species richness and community composition, as well as the water level logger measurements, there are some parameters which only need to be measured once:

- Collecting sediment cores at each marsh site, sectioning the cores to examine the soil bulk density and percent of organic material in the sediment to assess marsh conditions.
- Conducting a transect survey using RTK-GPS to allow for GIS analysis, so that the surface elevations across the marsh could be measured to compare between sites.

For the humanities historical research project, I will engage in historical source criticism and an interpretive methodological approach to the sources. The final paper will compare railway development and the change of wetlands coverage, with additional research dedicated to exploring the additional development factors such as animal husbandry and urban development.

- The first semester, I would focus on primary source research of topographic surveys in local archives and online databases which indicate the presence of wetlands, as well as identification of publicly sourced GIS data sets for later comparison.
- The second semester, I would focus on comparing coverage and calculating an estimate of the percent change of salt marshes in Connecticut.
- The final step would be creating a detailed timeline of railway development within Connecticut, using records of construction and maps from different time periods.
- This will be supplemented with additional research as the basis for the final paper.

References

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Learning and Project Plan

Student Name: Johann Heupel

Spring 2021

Courses

Dept &Course#	*Course Title*	*Credits*
MARN 3003Q	Environmental Reaction and Transport	4
MAST 4994W	Maritime Studies Capstone Seminar	3
MAST 3995	Maritime History	3
MARN 3000E	The Oceans and Global Climate	3
MAST 2300E	Marine Environmental Policy	3

Other Learning Opportunities

Opportunity	*Location/Date*

Project Milestones

Key Tasks
Research Summary of Historical Topographic Surveys for Historical Essay
Bibliography and Summary of Modern GIS Data Sets for Historical Essay
Initial Data Report and Logger Placement of Chosen Marsh Sites for Scientific Testing
Photographic Documentation of Chosen Marsh Sites for Scientific Testing

Summer 2021 (optional)

Courses

Dept &Course#	*Course Title*	*Credits*

Other Learning Opportunities

Opportunity	*Location/Date*
Hollings Undergraduate Internship	Location Variable/Summer 2021

Project Milestones

Key Tasks
Regular Data Collection of Chosen Marsh Sites

Fall 2021

Courses

Dept &Course#	*Course Title*	*Credits*
MARN 3001	Foundations of Marine Science	4
MARN 4001	Measurement and Analysis in Coastal Ecosystems	4
ECON 2467E	Economics of the Ocean	3
MARN 3505	Remote Sensing of Marine Geography	3
MAST 4999	Independent Study	2

Other Learning Opportunities

Opportunity	*Location/Date*

Project Milestones

Key Tasks
Comparative Coverage Analysis of Historic Topographical Surveys and Modern GIS Data
Research Summary of Northeast Corridor Railway Construction for Historical Essay
Regular Data Collection of Chosen Marsh Sites

Winter Intersession 2022 (optional)

Courses

Dept &Course#	*Course Title*	*Credits*

Other Learning Opportunities

Opportunity	*Location/Date*

Project Milestones

Key Tasks
Initial Outline of Historical Essay Structure and Findings
Regular Data Collection of Chosen Marsh Sites

Spring 2022

Courses

Dept &Course#	*Course Title*	*Credits*
MARN 4002	Science and the Coastal Environment	3
PHYS 1202Q	General Physics II	4
MARN 3060	Coastal Circulation and Sediment Transport	3
GEOG 3600	Global Dynamics of the Shipping Industry	3
MARN 4896W	Senior Research Thesis	3

Other Learning Opportunities

Opportunity	*Location/Date*

Project Milestones

Key Tasks
Final Regular Data Collection of Chosen Marsh Sites
Final Version of Historical Research Essay based on Comparative GIS Coverage
Final Version of Scientific Journal Article
Final Version of Summarizing Reflective Essay to Compare Research Essay and Journal Article Results